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CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

PUBLISHING OFFICE . . . . . 13-21 Park Row, New York
WESTERN OFFICE: 40 Dearborn Street, Chicago, Ill. . . CHARLES FFRENCH, Manager
EUROPEAN OFFICE: 42 Old Broad Street, London, E. C. . . HENRY W. HALL, Manager

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At the St. Louis World's Fair there will be an exhibit of prime movers of exceptional interest. One will there see all the appliances of the modern power-house and will be able to contrast the newer types of engine with the old. There will be shown some of the finest examples of the reciprocating steam engine, as well as of the newer prime movers, the steam turbines and gas engines of large power. It may be that this will be the last large exhibit of the reciprocating steam engine to be made, for while it can not be said that this type of prime mover has yet been superseded, the gas engine is coming into favor because of its high efficiency, and the steam turbine because of its suitability for electric power stations. And these two types have the element of novelty which furnishes the excuse for making an exhibit. In every-day use, however, the reciprocating steam engine will still find wide application, and it will probably be many years before this machine—which has undoubtedly been one of the most important civilizing factors in the history of the world—will be entirely supplanted, should that day ever come.

METER PERFORMANCE.

One of our lay contemporaries complains because, when making a few remarks about the conditions under which the electric meter must perform its work, we did not go further and explain what may be expected of these instruments, and whether they have a reputation for unreliability and eccentric behavior, which would put them in the same class as water and gas meters, or whether they stand alone.

The Performance of a Good Meter.

There are, of course, good meters and other meters. A good electric meter will be guaranteed by its maker to be accurate within two or three per cent. Indeed, meters can be had which are guaranteed to maintain this accuracy for three years, if not tampered with. A guarantee of this kind is quite satisfactory for commercial purposes, but the electric supply companies are not, in general, satisfied to take things for granted, but test their meters before putting them in place. Further, they test a meter for the consumer, if the latter thinks his instrument is inaccurate.

Tampering with Meters.

Electric meters should always be sealed to prevent tampering, and it may be remarked that it is risky for any one to attempt to influence his meter in any way. Not only are the companies well protected against this by law, but the person who endeavors to make his meter run slow may make it run fast. On the other hand, the wear and tear of service on these meters tends to slow them down, thus giving the consumer the benefit of the change in accuracy. The supply company can make a fair estimate of the power supplied to each consumer, and any sudden changes in the reading of a meter at once attract attention and lead to an examination of the premises.

THE FUNCTION OF THE FUSE ON AN ELECTRIC CAR.

One sees occasionally in the daily press an account of the blowing of the fuse on an electric car. This is described as a more or less serious accident to the car which caused, or very nearly caused, a panic among the passengers. Now, the greatest danger to the passengers lies in the possibility of some unexpected happening causing a panic. It is therefore most desirable that every one should know what may be expected to happen occasionally on a car, and that all should realize that the happening is not necessarily an indication of danger.

Overloads on an Electric Motor.

If a steam engine is overloaded it will stop and refuse to work, although the full pressure of steam may remain upon the piston, and not cause any damage. On the other hand, a motor when overloaded tries its best to do the work thrown upon it. If it can not run at full speed it will run at whatever speed it

can. As the speed decreases the current through the motor increases, and the motor adjusts itself to that speed at which the turning effort is sufficient to cause rotation and do the work. If the effort demanded of the motor is so great that the current which passes through it when standing still is not sufficient to cause rotation, the motor will, of course, not turn, but the current will continue to flow unless interrupted by a suitable mechanism.

The Action of the Fuse.

The current which will flow through a motor when it is standing still is in almost all cases far in excess of that which the motor is designed to carry; and, indeed, in a well-designed motor a current dangerous for the motor will be reached before the motor has been stalled. The effect of this heavy current on the motor, if allowed to continue, is to heat the windings to a dangerous degree and destroy the insulation, possibly setting it on fire; and it is to prevent this occurrence, whether due to careless handling of the car or to unexpected causes, that the fuses are used. A fuse is simply a short piece of wire of such size that it will be melted by a current which, if allowed to flow through the motor for any time, will damage it. When a fuse blows, then, it simply means that one of the safety devices on the car has operated to prevent damage to the motor. The melting of the fuse opens the circuit and cuts off the current from the motor. To protect the car the fuse is enclosed in a fireproof box.

The Circuit-Breaker.

There is another device for accomplishing this purpose, which is known as the circuit-breaker. This is a switch controlled by an electromagnet, which opens whenever the current reaches a certain dangerous value. This mechanism is now generally installed upon electric cars in addition to the fuse. It is often placed on the roof of the platform over the motorman's head, where it is easily reached and it is set to operate at a higher current value than the fuse, because the circuit-breaker acts almost instantaneously, while it takes a little time for the fuse to be melted. Now, a motor can stand for a second or two a current which would destroy it if applied for a longer period. The circuit-breaker, then, takes care of heavy overloads and the fuse protects the motor against those smaller currents which are dangerous if applied for a considerable time.

The Blowing of a Fuse.

When a fuse blows there is generally a volatilization of the metal of the fuse and a slight explosion. These explosions usually cause a report and some smoke. When the circuit-breaker is opened it draws an electric arc in breaking the circuit, and as in this arc a considerable amount of energy is dissipated in heating the air, there may be here also something of an explosion; but in neither case is there any danger to the passengers when the apparatus is properly installed. The fuse and the circuit-breaker are safety devices, the operation of which indicates, not that there is danger to those on the car, but that danger to the motors has been averted.

PROGRESS OF THE INTERNATIONAL ELECTRICAL CONGRESS.

We understand that the work of organization of the International Electrical Congress of St. Louis is going steadily forward, and that the movement is receiving the widest recognition, both at home and abroad. The second meeting of the Committee of Organization was held at the Cataract Hotel, Niagara Falls, N. Y., on September 18, with a full attendance of the executive committee and a good attendance of the general committee. A large amount of work was accomplished at this meeting, as during the lapse of time since the first meeting a number of committees have been at work formulating definite reports on certain branches of the congress programme.

Joint Meetings of the Electrical Associations and the Electrical Congress.

Among the more important matters that have now been definitely decided is that of the holding of joint meetings with the congress of several of our national electrical associations. The associations are to be invited to hold, if not all, at least a part of their annual conventions conjointly with sections of the congress. By this co-operation important papers by American engineers will be given a double prominence. They will be printed both as parts of the congress proceedings and in the transactions of the appropriate participating national electrical society.

Electrical Associations to Participate.

Thus far six of the national electrical societies have decided in favor of the electrical week at St. Louis as the time and place of their conventions of 1904, and have by their decisions assured not only the success of the electrical week, but have paved the way for the greatest assemblage of electricians that has ever congregated.

Invitation to Foreign Associations.

The congress committee will also extend invitations to all the foreign national electrical bodies. This action will stimulate the interest of over-sea electricians in visiting America next summer.

The individual interest of the foreign electricians in developing closer relations with their American brethren is shown by the fact that prominent electrical societies of the Old World are arranging to have official representation and headquarters at the exposition. It is their intent to make these headquarters tokens of the electrical development of the home countries, so that they may offer hospitality as from their own door steps.

Movement for International Standards.

One of the most important and perhaps far-reaching efforts of the congress committee is in the direction of starting a movement favoring international standardization in things electrical. A resolution, that passed unanimously, calls for pointed expression on this subject by eminent men of England, Germany, France, Italy, etc. It is to be hoped that all that, and more than, the resolution contemplates will be forthcoming, and that the chamber of delegates of the congress will find the time ripe for the establishment of a permanent committee on international electrical standardization which will from time to time report to properly accredited electrical bodies in the participating countries.

HIGH-SPEED TRAINS.

In a recent issue one of our esteemed engineering contemporaries took occasion, in noting the successful attempts made in Germany to run cars over a special road at speeds exceeding one hundred miles an hour, to make a few well-considered remarks upon the desirability and practicability of running trains at such high speeds under ordinary conditions.

Are Fast Trains Desired?

The question was asked, who would care to travel at such speeds? The answer to this can only be found by an actual trial, but one can not help thinking that there is a large number of travelers who would be attracted by very fast trains. In addition to the time saved, there is keen enjoyment in fast traveling. However, few passengers board a train for the pleasure of riding. They always want to go somewhere, and, in general, the sooner they get there the better. Therefore, the faster the train, the better are they pleased. It is not to be expected that high-speed trains will be put in service unless they can be operated with safety and comfort; but if high-speed operation can be shown to be safe, we do not think that the railroads will have difficulty in securing passengers.

Fast Running Brings Signaling Troubles.

Our contemporary also points out how difficult it will be to operate a road over which trains are run at one hundred miles an hour by the block signal system, and the sensible conclusion is reached that such trains can only be run over a track built for them alone. It is said that a mechanical signal can not be worked satisfactorily with a greater length of wire than 2,000 feet. With the present train speeds it is not uncommon to place the distant signal 2,500 feet back of the home, and, therefore, for trains running at one hundred miles an hour, the distant signal ought to be at least 7,500 feet back, because the power stored in a railway train varies as the square of the speed, and all of this must be absorbed by the brakes to stop the train. The difficulty of operating a mechanical signal at this distance can, of course, be overcome by using some other system. An electrical signal can be operated at a distance of 7,500 feet as easily as at a distance of seventy-five.

Another trouble with such high speeds will be in giving an engineer a signal which can not be misunderstood. With a train running at one hundred miles an hour and a signal that can be seen 1,000 feet away, the engineer has less than seven seconds to verify the reading of the signal. If the signal, due to weather conditions, or otherwise, can not be seen for more than 200 feet, the engine runner would have just one and one-half seconds to decide whether his train was dashing to safety or destruction. Can not this difficulty be overcome by installing these signals, not singly, but in duplicate or triplicate a proper distance apart? There would be no more difficulty in operating three signals placed, say, 500 feet apart, electrically from a station 7,500 feet away from the nearest one, than to operate one. Moreover, a number of engineers are working on automatic signal systems which will, in addition to the signal on the side of the road, operate a signal within the engine cab. A system of this kind would overcome all signaling difficulties.

High-Speed Roads Not Improbable.

It is hardly possible that sustained speeds of one hundred miles and more will be common for some years, but it would be unwise to predict that such speeds are not practical. In addition to the special track, a high-speed line should be completely fenced in and there should be no grade crossings either of other lines or wagon roads.

SHOP TESTING OF MOTORS AND GENERATORS FOR COMMERCIAL SERVICE—IV.

BY BERTRAND B. ABRY.

THE DIRECT-CURRENT SERIES (RAILWAY) MOTOR.

It is here proposed to discuss the shop tests and characteristic curves of the railway motor in particular and the ordinary series motor in general.

The varying conditions of railway work, such as loads and speeds, necessitate a motor which will meet these conditions, if satisfactory service is to be obtained. The series motor is essentially a variable field machine. It is this inherent feature that makes it especially adaptable to railway service. For example, a large starting torque is necessary to accelerate a car, and the series motor meets this requirement, by virtue of its automatically varying field. The operation of "throwing on" the controller gradually increases the voltage across each motor with a corresponding increase in speed. After reaching full multiple we have practically a constant voltage, but on a level there is an excess torque over and above what is actually needed to overcome the resistance to the moving car. This excess torque will continue to accelerate the car, the rate of acceleration gradually decreasing until the torque exerted by the motors just balances the train resistance, when the speed becomes constant. As the rate of acceleration gradually decreases until constant speed is reached, the torque and current also diminish, and thus the motor field strength is automatically varied with the speed.

These inherent features are, of course, characteristic of the series motor in general, but it is especially desired to study the usual tests applied to a railway motor, since this type of a series motor is perhaps most extensively used and best known.

As earlier pointed out, there are two general classes of tests: those applied to new designs and carried out in detail, and tests less complete and of a general nature, applied to standard motors built in large numbers.

We will consider in this case the usual shop tests taken on some one particular design, since the general tests made on standard motors built in quantities consist mainly of temperature runs and insulation tests. We will assume that a new motor has been built and that the following tests are to be made:

1. Iron loss and friction test.
2. Friction test.
3. Speed test.
4. Brake test.

1—IRON LOSS AND FRICTION TEST.

In this test the motor is wired as shown in Fig. 10. It is not belt-driven as in the case of shunt and compound motors, because in a series motor any change in the field current produces a like change in the armature amperes, and hence the shunt-motor method of measuring iron loss is not used. As shown in the diagram, a resistance rack is placed in parallel with the motor armature, and most of the line current shunted through it.

Just enough passes through the armature to supply the iron and friction loss.

The voltage across the armature is held constant throughout the test and the following observations made:

Speed.	Main Amperes.	Armature Amperes.	Armature Volts.	Watts Lost (Calculated).

The last column is calculated from the armature amperes and volts. The product is the watts lost in the iron and the bearing friction and windage. Note that these losses are inseparable in this test, due to the fact that there is always some friction, and more or less windage. The iron loss is a function of the current and voltage, therefore, after computing the watts lost for different currents, we may plot what is called the iron loss and friction curve, as shown in Fig. 11. It is customary to plot also the ampere curve at the same time. It now remains to determine the friction curve itself. When this is plotted, the difference in the ordinates of the two curves will give the iron loss at different loads.

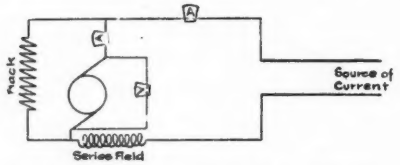


FIG. 10.—WIRING FOR IRON LOSS TEST.

2—FRICTION TEST.

To make this test disconnect the rack entirely and run the motor "light;" *i. e.*, begin with an impressed voltage of fifteen or twenty volts, increasing gradually, say, twenty-five volts at a time until the limit of armature speed is reached. For each impressed voltage the current will not exceed an amount equal to the friction and windage loss. The voltage and current being low, the iron loss is negligible. When ready to begin the test observe the following:

Speed.	Armature.		Watts Lost (Calculated).
	Amperes.	Volts.	

As before, the watts lost are computed from the armature amperes and volts. Taking speed and watts as ordinates, the friction curve is plotted with the iron loss and ampere curve. Their general shape and relation to each other are indicated in Fig. 11.

Theoretically the friction varies directly as the speed and we would expect to obtain a straight line. Actual results, however, give in most cases a friction curve bending upward slightly at higher speeds. This may be accounted for as follows:

Higher speeds are obtained by increasing the voltage, consequently the "negligible" iron loss increases slightly. The windage also increases and adds to this loss, especially at the higher speeds. On the other hand, cases have been noted where the friction curve bends downward. This would indicate a decreasing bearing friction, but it is an exceptional case.

Attention is called to the relation of the ampere and iron loss and friction curves. Since the iron loss is a function of the current, we would expect changes in the current to produce corresponding changes in the iron loss. That these changes do occur is quite evident from the curves. As the motor speeds up the current decreases and the iron loss likewise. We would expect this relation to continue until the motor speed became constant. However, it

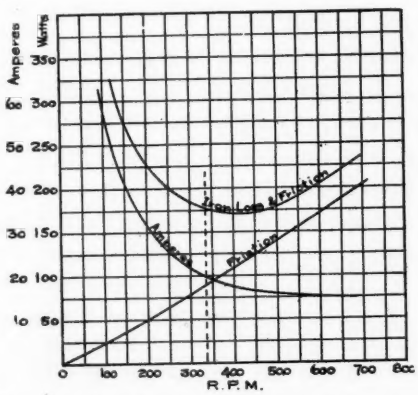


FIG. 11.—IRON LOSS AND FRICTION CURVES—SERIES MOTOR.

will be noted that the iron loss and friction curves bend upward after a certain speed is reached, instead of continuing downward with the current. This is due to the fact that at low speeds the ratio of the iron loss to the friction is large. This ratio gradually approaches 1 and at a certain speed equals 1, as indicated by the vertical dotted line cutting the two curves in Fig. 11. As the speed increases beyond this point, the inverse ratio holds. That is, the ratio of the friction to the iron loss gradually increases. In other words, although the iron loss tends to decrease as the speed goes up, the friction increases faster after a certain speed is reached, and the result is an upward bend in the curve.

Having plotted these curves accurately we may at once determine the iron loss itself by measuring the difference of the ordinates of the two curves at different speeds.

It is usually customary to plot these differences, or the actual iron loss, in the shape of iron loss curves, for any current desired. We will assume that it is desired to plot the iron loss curves corresponding to 100, 150, 200 and 300 amperes. Take for the ordinates, volts and watts as shown in Fig. 12. Then from the test curves corresponding to Fig. 11 find the loss in watts, as explained above, for different speeds and corresponding voltages. For convenience, tabulate as follows:

Amperes (Say, 100).	Volts (Corrected for Total Drop in Machine).	Watts Lost, or Iron Loss (Difference of Ordinates of Two Curves).

Since the iron loss is also a function of the voltage, to obtain true curves the voltage must be corrected for the total drop in the machine (which is the total resistance drop plus the brush drop) for the particular current chosen. That is, at 100 amperes the total drop corresponding to this current, and depending on the total resistance and brush drop, must be added to the voltage. Hence if we have noted the watts lost corresponding to certain observed voltages, say, 150, 200, 300, etc., we must increase these an amount equal to the total drop in the machine which we will assume amounts to ten volts at 100 amperes. Therefore the "watts lost" points on the 100-ampere iron loss curve should be plotted at 160, 210, 310, etc., volts.

In this manner any number of iron loss curves may be plotted for different currents. From the general shape of the curves it will be noticed that the iron loss does not vary in direct proportion to the voltage. In an actual case, where the curves are plotted accurately, it will be found that doubling the voltage increases the iron loss from two and one-half to three and one-half times.

Attention is also called to the fact that these curves do not pass through the origin, for the reason that it is necessary to impress a certain voltage on the motor sufficient to overcome the drop in the machine before it will operate; and the larger the current the greater the drop, hence for the larger currents the curves cross the X axis at points still further from the origin.

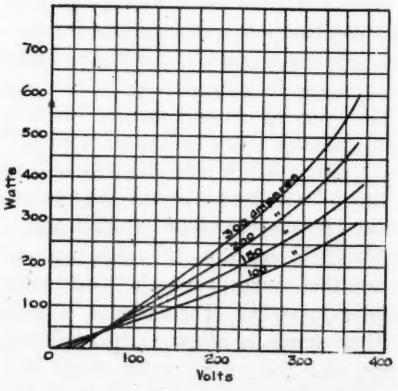


FIG. 12.—IRON LOSS CURVES—SERIES MOTOR.

THE ROYAL COMMISSION ON LONDON TRAFFIC.

(From Our Special Correspondent.)

The following full text of the reference to the Royal Commission, appointed early in the year to enquire into the means for transportation in London, conveys at once the far-reaching character of the enquiry which is now being instituted. To enquire into the means of locomotion and transport in London and to report (*a*) as to the measures which they deem most effectual for the improvement of the same by the development and interconnection of railways and tramways on or below the surface, by increasing the facilities for other forms of mechanical locomotion, by better provision for the organization and regulation of vehicular and pedestrian traffic or otherwise, and (*b*) as to the desirability of establishing some authority or tribunal to which all schemes of railway or tramway construction of a local character should be conferred, and the powers which it would be advisable to confer upon such a body.

The first thing attempted was an enquiry into the efficiency and sufficiency of legislation as applied to locomotion and transport, chiefly tramways. At present in Great Britain powers to build tramways are obtained as follows: (1) By a provisional order granted by the Board of Trade under the Tramways Act of 1870. In this case the provisional order has to be confirmed by Parliament. (2) By a bill promoted by Parliament itself. (3) By a light railway order granted by the Light Railway Commissioners under the Light Railway Act of 1896. In this case the order has to be confirmed by the Board of Trade, without any reference whatever to Parliament. At the very commencement of the enquiry it was conceded by the Board of Trade officials that this legislation was unsatisfactory and conflicting for many reasons. For instance, the Tramways Act of 1870, as is obvious, was drafted at a time when electric traction in its present day form was not dreamed of; yet practically not one modification of it has been attempted. The one outstanding objection to it is what is termed the local veto, or the clause which makes it incumbent upon promoters to obtain the consent of the road authority before any scheme may even be put before Parliament. The standing orders of Parliament render it impossible for any bill in connection with which this condition has not been fulfilled being even accepted. Again, the terms of purchase under the 1870 Act are such that a tramway company would, at the end of the twenty-one years or so, receive from the local authority taking over the lines nothing whatever for good will, and merely the material price of the undertaking, *viz.*, stock, etc. Thus there has never been any inducement to a company to keep its undertaking in an efficient condition, unless better terms have been arranged with the local authority.

These disadvantages, however, while not applying *en bloc* to the other two methods of legislation, nevertheless reflect upon them. It is possible for two rival promoters for the same district to seek powers under different legislation, and the mere fact that one body gets through its business quicker than the other, gives the line over to one promoter without any consideration of which scheme is best suited to the needs of the locality. All these, and many other points, were given in evidence before the commission, which, more or less recognizing the unworkable nature of the legislature's machinery, asked for opinions as to the desirability of establishing a central authority or tribunal before which all schemes of locomotion relating to London should be placed.

All over Great Britain we have what are known as the tramway authority and the road authority. In many provincial towns these powers are both vested in the local authorities, so that conflict of parties is to a large extent avoided. In London, however, the London County Council is the tramway authority, and each of the twenty-seven borough councils is the road authority for its own district. Thus the present position is that any private company wishing to construct new lines has to obtain the consent of both the county council and the borough council, and the county council, for its tramway schemes, has to obtain the consent of the borough council. The borough councils are precluded by law from constructing tramways, and although the county council has leased some of its lines to a company in the north, it has now set its face against any company-built lines being again undertaken, although Parliament did this year override the county council in one particular instance in respect of a very short length of line near the borders of the county. To all intents and purposes this leaves the question of locomotion in London in the hands of the London County Council and the London borough councils, the latter having the right to veto any scheme for tramways put forward should it so please, a position which, naturally, is not very acceptable to the county authority. There has always been friction between these various borough councils and the county council, particularly in respect of road widenings for new tramways.

Now as to the establishment of a special tribunal having full and complete jurisdiction in regard to means of locomotion, there was a pretty general consensus of opinion that the existence of such a body would be beneficial, for, from the tramway company promoters' point of view, it would at once abolish the local authority veto, and allow any scheme to be put forward for consideration. But the London County Council asserts that it and it alone should be the deciding factor in tramway matters, and that the abolition of the borough council veto would only mean that it (the county council) would have to submit to examination at the hands of another and more powerful body without in its turn having any control over outside promoters coming into London. Its proposition was, therefore, that a special tribunal as proposed should be established for the purpose of dealing with railways only, and that the county council should have the final word in the matter of tramways.

An attempt was also made by the Royal Commission to ascertain from witnesses expert opinions as to the best means of extending the present means of communication, but it must be confessed that very little agreement has, as yet, been arrived at. In spite of the underground shallow tunnel tramway which is now being constructed in one portion of the city, this method is not highly thought of unless, as in this instance, it is built with a new street.

Surface tramways are impossible in the city and its immediate connections owing to the narrow streets and disinclination of the city authorities to agree. Therefore it looks as if the suggestion that surface tramways should run from the suburbs as near the inside as possible, and then for passengers to continue across the city with tube railways, was the only one left. The tube railways come to the centre of the city and stop there, thus increasing the congestion at that point.

Evidence will be tendered at the resumption of the sittings by tube railway and other managers. In the meantime, however, all progress regarding means of locomotion in London has been stopped pending the report of the Royal Commission.

London, October 17. A. W.

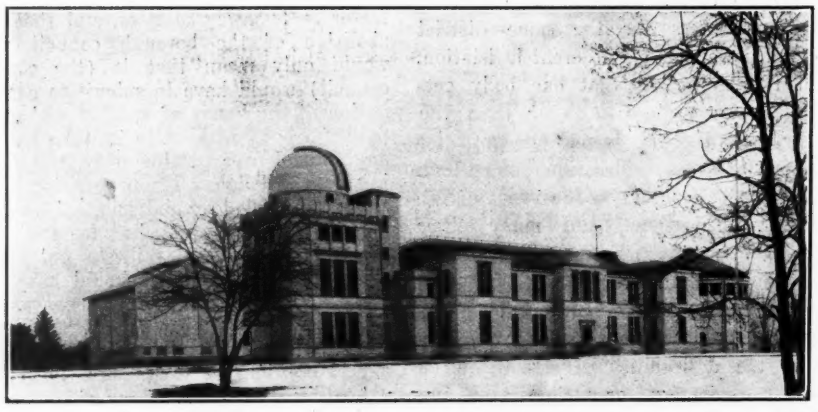
The Electrotechnical Institute of Montefiore.

The catalogue of the Electrotechnical Institute of Montefiore, at the University of Liege, Belgium, has been received. This gives a good description of the electrical equipment and illustrates the apparatus used in the study of intense currents, high potentials, machine testing and operation, study of wave-forms, etc. Courses are offered at this institution in mining engineering, electrical engineering, electrochemical engineering and mechanical engineering.

ELECTRICITY IN THE UNITED STATES GOVERNMENT SERVICE.

BY J. E. PRICE.

In the matter of using electricity Uncle Sam sets a good example to his progressive people. He employs it for light and elevator service in the department buildings, for running machinery, and also for lighting in his huge printing office, money-manufacturing shop and navy yard at Washington; and then he uses it



MAIN BUILDING, NAVAL OBSERVATORY.

in three peculiar ways, in connection with the heavens, the earth and the air. To these latter interesting features may be added a magnetic department, which has to do with scientific study, not much known to the public.

Two of the peculiar electric features mentioned are found at the Naval Observatory—which is located on Georgetown Heights, near Washington, D. C.—and they concern the getting of correct time and its distribution for public clock service. The other feature is wireless telegraphy, about which much has been written, of experiments being made by the government and the use of such an invention in connection with the life-saving service, etc.

In regard to "keeping tab" on time electricity, of course, is not the main factor, but it is a most useful and necessary adjunct, and it marks time—sets clocks in many places with unfailing regularity.

There are many clocks at the Naval Observatory, but those which are connected with the chronograph department are of most interest. They embrace the electric feature in the time system; some having to do with mean time, but the most important one with astronomy.

This timepiece is called the sidereal (star) clock, and is used in connection with the transit circle. It is connected with a chronograph, in the same room, and with the galvanic system of the observatory, by means of a platinum rod, and a small globule of mercury. The latter is so arranged on a metallic support, that at each oscillation of the pendulum the platinum point touches the mercury when the pendulum is at the middle of its arc, closes the circuit and transmits its fractional time message, to be recorded by an automatic marker on the table-sheet on the chronograph. Thus a continuous marking goes on, unless interrupted; and this interruption plays its important part in getting correct time.

Contrary to public idea, getting exact time does not depend mainly upon sun observation. One rotation of the earth, according to opinions of scientific time-gaugers, does not make a complete day; but the time between the appearance at meridian of a fixed star and its reappearance in the same position, gives the exact diurnal period.

The observer, through the transit telescope—across the smaller end (inside) of which are stretched a number of spider-web threads—marks the star almost at meridian, and as it comes to the meridian line, outlined by the threads, he presses an electric button, or lever, and thus causes the recording-pen of the chronograph, above mentioned, to leave its zig-zag course around the revolving sheet and make a short line, which represents meridian star time.

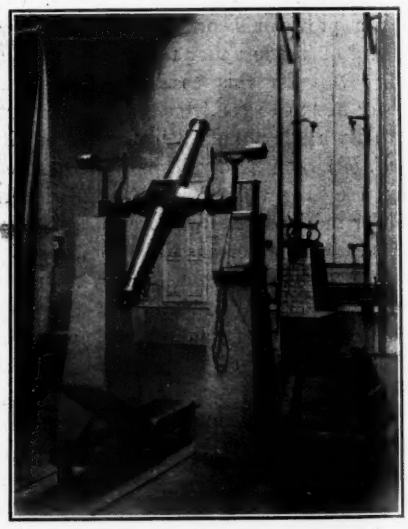
Now the sidereal clock record is compared with absolutely correct star-time tables, which show what the proper record should be; and then the difference, if there is any, between clock and table is corrected and the result is perfected by reference to the mean time chronographic record. After figuring out all differences, "time is in condition" to be electrically recorded wherever there is a clock connected with the wires of the Western Union Telegraph Company.

To this company "time is surely money"—and money all the time. And not a cent is paid to Uncle Sam for his time—the time it takes him to make first-class time—and also nothing for wear and tear of instruments.

The telegraph company makes about $1,000,000 per year out of this time business, in which it is without a rival—although the government will give to any one who can utilize the privilege the service rendered the Western Union company. But that company now gives all necessary service desired, keeping about 70,000 clocks correct, charging for so doing $15 per year for each clock.

These are set at noon each day by an automatic arrangement in each electric equipment, which responds to the beat of the sidereal clock in the Naval Observatory, when its hands point to twelve and let the time current go.

A few minutes before this hour business over the Western Union wires is suspended, and operators throughout the country put their instruments in shape to form an unbroken circuit, from the observatory to every place where ticks a clock to be electrically influenced. There is a hush over all the great telegraphic system. Then the time bell strikes, and



TRANSIT TELESCOPE.

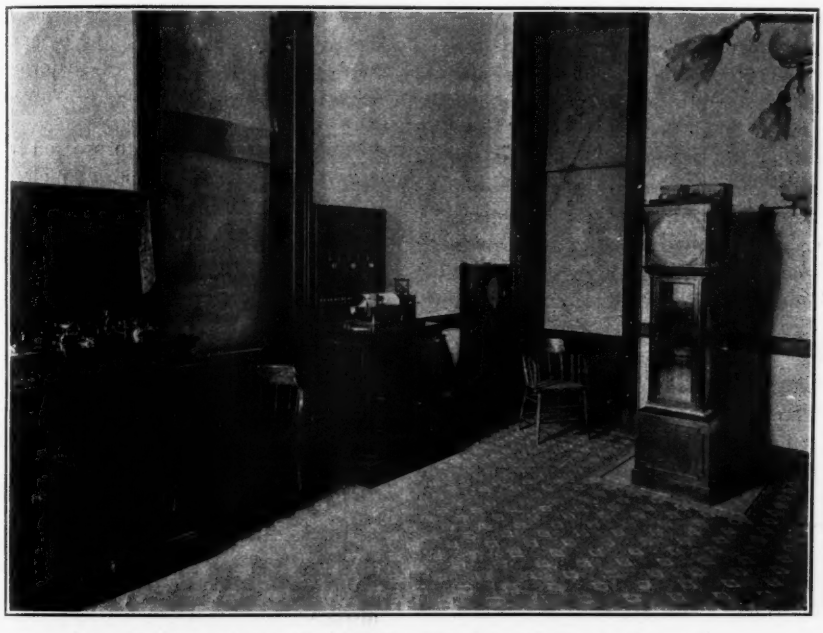
instantly the time-message flashes over the wires. It is twelve o'clock.

Concerning earthquake shocks, electricity acts as a registering force. Until the electric cars, which run near the Naval Observatory, began the too free distribution of current, there were at that place an earthquake detecting arrangement and a magnetic observatory—two attachments of much scientific interest. But, though the magnetic department does not now form part of the observa-

tory's outfit, there are four others belonging to the government. These are located at Los Angeles, Cal.; San Antonio, Tex.; Madison, Wis.; and Key West, Fla.

For detecting earthquake shocks a seismograph and seismoscopes are used. These are set upon solid foundations, which can be affected only by earth tremors. There are two seismoscopes employed; one being set upon a pier in a separate building, where are also clocks electrically connected with both seismoscopes in such manner that when the earth begins to tremble they leave their supports and thus start an electric current which stops the clocks, and record of the occurrence is made by the seismograph.

Another source of earthquake information is found in the magnetic observatory. One of the latter—as seen by the writer at the Naval Observatory—was situated both above and underground. The above



INTERIOR OF TIME-SERVICE ROOM, SHOWING STANDARD CLOCK.

ground portion consisted of a small one-story structure (in which could be seen many peculiar instruments, dip-circle apparatus, seismoscopes, compass-testing stand, etc.) and a big conical earth mound, the latter perforated by ventilating pipes. Underneath this mound (the building and mound are still there) there was a room in which was kept a magnetic outfit used for gathering data concerning terrestrial magnetism.

It is known that the earth is a huge magnet, and that it is continually emitting magnetic waves which have their courses and influence according to conditions. One manifestation of magnetic current was recently witnessed in the marked disturbance of the magnetic needle at one of the magnetic observatories in this country, near the time of the second eruption of Mount Pelee.

The underground room mentioned had double walls with air-spaces, and was kept at an even temperature. The work done there was carried on principally by what might be called "automatic photography."

The apparatus consisted of three balanced magnetic needles enclosed in a glass case, each mounted on a stone pillar, a clockwork paper-sheet carrier, and three narrow wooden channel boxes, each about six feet long. The boxes branched out from a central box which contained the clockwork machinery, and each entered the needle case situated at its end. At the back of each of the three needles there was a small mirror reflector which, with the aid of a spot of light centered on each, projected the position of the needles through the channel boxes and upon a sheet of sensitized paper. The latter, by action of the clockwork, had a continuous movement, and thus, for a period of two days, took a photographic outline of all the motions of the magnetic needle, caused by magnetic disturbance. If, when the sensitized paper was taken out of the machine and developed, only straight lines were found, no magnetic disturbance had occurred; the zigzag line told of the presence of magnetism.

SHOWING TRANSIT INSTRUMENT HOUSE AND DOME, 26-INCH EQUATORIAL TELESCOPE HOUSE.

The chief business of a magnetic observatory is the study of atmospheric electricity and earth currents, their force, direction, etc., thus obtaining scientific information which may be applied in several ways. One of these relates to the correction of the mariner's compass. And when there is an earthquake disturbance the magnetic needle is influenced by increased flow of earth current, sometimes before the earth begins to shake.

Animal Mechanics and Motor Vehicle Designs.

The reason for the failure of many of the early types of automobiles is discussed in the *Mechanical Engineer* (London), in its current issue. At first sight a three or four-horse-power motor would seem to afford ample margin, but experience soon taught the fallacy of comparing these machines with horses. The average output of a horse is generally estimated at 22,000 foot-pounds per minute, though Watt, in his desire to be generous, allowed fifty per cent more than this, and counted 33,000 foot-pounds per minute as one horse-power for his engines. This rating is for continuous effort, but for a short time a horse is probably capable of doing work at ten times this rate, as, for instance, in starting a heavy load or drawing up hill; and it is this element of flexibility which automobile designers did not take into account. These considerations show why a motor vehicle, to maintain an average speed of, say, twelve miles an hour, requires a motor of a very much greater power than one operated by animals. The motor, in fact, must be armed with sufficient power to meet any emergency, and this at times may be ten times the average demand.

Great power provision, however, brings other troubles in the shape of additional weight, and a satisfactory solution of high speeds and comfortable traveling in a motor vehicle is to be sought in increasing the power without increasing the dead weight. It is in this direction that the French builders are developing their business, and this explains their success in building motor-driven vehicles.

TOTAL AND FREE ENERGY OF THE LEAD ACCUMULATOR.[1]

BY R. A. LEHFELDT.

In choosing a subject on which to address the opening meeting of the Faraday Society, it seems to me I could not do better than deal with some points in the theory of the accumulator. It is a subject in which technical and scientific interests are thoroughly combined; and it is perhaps not very generally known how completely electrochemical theory has been found to harmonize with the experience of technicians, how satisfactorily it brings together many experimental facts, and how suggestive it is. I have little to say to-night that is new; what I aim at is to bring into as clear a light as possible one salient aspect of physics as applied to the lead accumulator of the technical electrician.

The chemical reaction of the accumulator I take to be

$$\tfrac{1}{2}Pb + \tfrac{1}{2}PbO_2 + H_2SO_4 \rightleftarrows PbSO_4 + H_2O.$$

(Read from left to right on discharge, and from right to left on charge.[2])

That this, on the whole, accords with the facts there can be no doubt. The evidence in favor of it—chemical, electrical and thermodynamic—is a more than sufficient proof. It is quite possible that certain minor points are not explainable without taking other actions into account. Elb's observations on plumbic sulphate, $Pb(SO_4)_2$, seem to show that that substance plays an important part, at least in the formation of spongy lead. But it will not be necessary for my present purpose to pay attention to such possibilities.

Taking the above equation to be correct, I wish to point out how the general laws of energy allow one to draw conclusions with regard to the electromotive force of the cell in which the reaction takes place.

For the purpose of analyzing the transformations of energy involved, the reaction on discharge may be regarded as consisting of three parts:

(a) From the electrolyte of the accumulator remove one molecule of sulphuric acid (H_2SO_4).

(b) Cause this to react with the dry solids Pb and PbO_2.

(c) Mix the molecule of water thus formed with the electrolyte.

Action (b) is the same, whatever the concentration of the electrolyte may be; actions (a) and (c), on the other hand, involve that concentration. Accordingly, we may separate the energy, and therefore the electromotive force of the reaction, into a fixed part, depending on (b), and a part varying with concentration, depending on (a) and (c).

We have then to determine the energy changes involved in these processes; the method is applicable to both the total and the free energy. It would be inappropriate to go at length into the distinction between these two quantities; yet I can not help remarking that the distinction, which has occupied physicists for a quarter of a century, is not generally enough noted even now. And as the conception of free energy is the most important of all in physical chemistry, it can hardly be insisted on too much. It is, moreover, one of which it is very difficult to form any mechanical image.

When a chemical system suffers a transformation, such as that involved in the action of the accumulator, it loses a certain amount (sometimes negative) of energy, and since all energy, indiscriminately, is capable of transformation into heat, it is only necessary to perform the reaction in a calorimeter to find out how much. But all energy is not indiscriminately capable of doing work—despite its name—and with a chemical change a certain amount of ability to do work is associated; this amount being distinct from the change in total energy. Moreover, it is not mechanical work merely that is in this position; many kinds of energy, perhaps all except heat, are freely interchangeable among themselves, and yet not with heat.

We have therefore to recognize two grades of availability in energy—not an indefinite gradation, which would perhaps be easier to understand, but two planes, so to say, a higher and a lower. With regard to the former, a chemical reaction has a certain energy value; with regard to the latter, another energy value, which may be either greater or less than the first. The value on the higher plane—*i. e.*, of chemical, electrical, mechanical actions—is called the free energy of the reaction; that on the lower plane, of thermal actions, the total energy. And the total energy is "conserved" in any case; the free energy is conserved if the action remains within the limits appropriate to the higher plane.

I—TOTAL ENERGY.

There are many ways of expressing the composition of a sulphuric acid solution. It will be most convenient to choose the molecular fraction in the present instance; *i. e.*, if z molecules of H_2SO_4 be mixed with $1 - z$ molecules of H_2O, z is taken as the expression of the strength of the acid. As an instance of the meaning of this, I take an acid of ordinary strength, for which $z = 0.05$. This may be stated in various forms, as follows:

Molecular fraction, . .	$z = 0.05$.
Composition, ...	$H_2SO_4 . 19H_2O$.
Percentage by weight, .	24.27% H_2SO_4.
Grammes H_2SO_4 per litre,	258.
Normality, ...	5.26 equivalent per litre.
Density, ...	1.161.

Let χ be the heat of reaction of the pure materials (process (b) above) for the quantities shown in the chemical equation, and let Q be the heat of formation of the dilute acid used as electrolyte, per molecule, *i. e.*, Q is the heat evolved by mixing z H_2SO_4 with $(1-z)$ H_2O. [In the example chosen, mixing 0.05 molecule or 4.9 grammes of strong sulphuric acid with 0.95 molecule or 17.1 grammes of water.] Q is found by experiment, and we have to express in terms of it the changes of total energy involved in (a) and (c).

Suppose the reaction to proceed to an infinitesimal extent, so that dz molecules H_2SO_4 are used up, and dz molecule H_2O formed, for every molecule of electrolyte. Then the concentration which was formerly z has become $z - dz$. The heat evolved (negative in amount) in consequence of the removal of acid, and that (positive) due to addition of water to the electrolyte, are together expressed by $-\frac{dQ}{dz}dz$. Hence in processes (a) and (c) the heat is $-\left(\frac{dQ}{dz}\right)$, and the total heat of reaction of the accumulator is expressed by—

$$\chi - \frac{dQ}{dz}$$

This conclusion, only in a less simple form, was, I think, first arrived at by Dolezalek,[1] to whom the theory of the accumulator owes so much.

Q has been determined by J. Thomson, Pickering and others. I have taken Pickering's numbers[2] in the following calculations. When Q is plotted as a function of z the curve obtained is hardly regular enough to take differential coefficients off; I have therefore adopted the artifice of combining the graphical method with an empirical formula. Over the range required, *i. e.*, from $z = 0$ to $z = 0.25$, the curve is roughly parabolic. I therefore choose a parabolic formula conven-

[1] A paper read before the Faraday Society, June 30, 1903.

[2] I have written the above equation with the quantities required to convey one "faraday" of electricity (96,000 coulombs). This, I think, is a practice that electrochemists might adopt generally with advantage.

[1] *Wied. Ann.*, 65, 896.

[2] *J. C. S.*, 57, 112.

ient for calculation—not necessarily the nearest to the truth that can be found—and draw a curve showing the differences between this and the experimental data.

Before giving the numbers it is necessary to remark on the unit used. Quantities of heat are properly expressed in joules—no electrochemist, I hope, will use the unsystematic, inconstant and unnecessary calorie. For electrochemical purposes it is desirable to express all heats of reaction per equivalent, and not, as in thermochemistry, for molecular quantities; but we may go a step further and divide the result by 96,600—the number of coulombs transported by an equivalent of matter. The result will be a number of volts corresponding to the heat of the reaction, and one may be permitted the slight inaccuracy of saying, for brevity, the "heat of reaction in volts." It must be remembered, of course, that the number of volts thus arrived at is not that actually given by the reaction, but that which would be given if all its energy were spent in producing current.

With this explanation, then, I may say that the heat of formation of sulphuric acid solutions is roughly—

$$Q = 0.8\,z - 1.2\,z^2 \text{ volts.}$$

The deviations from this formula are too large to ascribe to errors of experiment; I have therefore plotted them on a large scale diagram. To determine $\frac{dQ}{dz}$ I calculate from the above formula $0.8 - 2.4\,z$, which forms the greater part, and get the small correction by tangents to the curve.

The results are given in the following table:

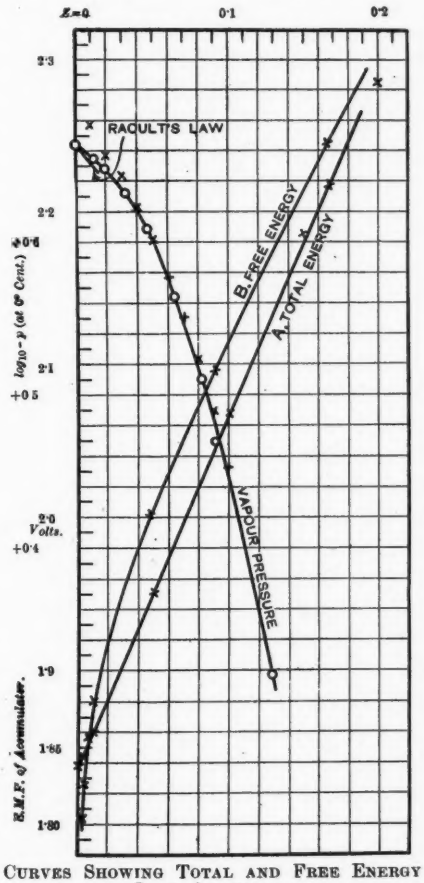
z	$\frac{dQ}{dz}$ (volts)	
0	0.787	From Pickering's measurements. Temperature, 18°.
0.0025	0.781	
0.01	0.765	
$\frac{1}{3}$I	0.680	
0.05	0.674	
$\frac{1}{11}$	0.579	
0.10	0.557	
0.15	0.440	
$\frac{1}{6}$	0.407	
0.20	0.340	
0.25	0.253	

These numbers give the variation of the total energy of reaction; but we have also to find χ in order to know the total energy itself. Two methods are available. The heat of reaction has been found calorimetrically in the case of acid of strength $z = 0.0025$. Tscheltzow[1] gives for the molecular quantities 88,800 calories = 186,580 joules per equivalent, or 1.931 volts; Streintz,[2] from a different series of reactions, 86,800 calories = 182,280 joules = 1.887 volts.

Secondly, we may adopt the thermodynamic formula $(E - T\frac{dE}{dT})F$ for the heat of reaction.

(Where E = electromotive force
T = absolute temperature
F = quantity of electricity.)

If we adopt the same mode of expression for the quantities of energy as before, F = 1, and the "heat of reaction in volts" is given by $E - T\frac{dE}{dT}$ merely.



CURVES SHOWING TOTAL AND FREE ENERGY OF LEAD ACCUMULATOR.

The degree of consistency between the data may be judged by the table below, in which χ is calculated by both methods.

The numbers in the last column should, of course, be constant; they actually vary by 1 to 2 per cent from the mean, which, considering the number and difficulty of measurements involved, is fairly satisfactory. χ, as calculated from the heat of reaction, is certainly too high, so it appears that this has been overestimated. The true heat of reaction is probably less than even Streintz's value.

Taking the mean value of χ and combining it with the tabulated values of $\frac{dQ}{dz}$ as the most trustworthy final results, we get what is shown in the figure, curve A. This is the total energy of the reaction—

$$\tfrac{1}{2}Pb + \tfrac{1}{2}PbO_2 + H_2SO_4 \rightleftarrows PbSO_4 + H_2O$$

expressed by its equivalent in volts, for various strengths of acid.

II—FREE ENERGY.

The free energy of a reaction may be estimated in various ways, and two of them have been actually worked out for the accumulator.

(1) The first is to measure the electromotive force (E). For this, multiplied by the quantity of electricity (F), flowing, gives the electrical work done (EF); or abbreviating, as before, we may express the equivalent of the free energy by the voltage E merely. Herein lies the extreme importance of electromotive-force measurements in physical chemistry.

(2) We may compare the free energy values in two solutions of different strength by studying the process of distillation. If two accumulators with electrolytes of different densities be put in opposition, the stronger will charge the weaker; the total amount of Pb, of PbO_2, and of $PbSO_4$ will be unchanged; but there will be less strong acid and more weak after the action is over. Now just the same thing could be accom-

TEMPERATURE FIFTEEN DEGREES.

z	Heat of Reaction.				$\frac{dQ}{dz}$	χ
0 0025	1.923				0.781	2.704 Tscheltzow
do.	1.879				do.	2.660 Streintz
	E	$\frac{dE}{dT} \times 10^5$	$T\frac{dE}{dT}$	$E - T\frac{dE}{dT}$		
0.01	1.881	− 7	− 0.020	1.901	0.765	2.666
$\frac{1}{3}$I	2.002	+ 33	+ 0.092	1.910	0.680	2.590
$\frac{1}{11}$	2.097	+ 11	+ 0.032	2.065	0.579	2.644
$\frac{1}{6}$	2.246	+ 6	+ 0.017	2.229	0.407	2.636
....	2.348	+ 4	+ 0.011	2.337	0.253	2.590
					Mean	2.625

[1] *C. R.*, 100, 1458 (1885).
[2] *Wied.*, 53, 698 (1894).

plished by distilling some water from the weak accumulator into the strong one, and some H_2SO_4 from the strong into the weak. I need not go into details of the process, as these have been worked out by other writers; but it is clear that if we take E as the measure of the free energy of the accumulator reaction with acid of a certain standard density, we can find what it is for any other strength of acid in terms of vapor pressures.

I have collected and recalculated the best data I can find as to these two methods, and the results are shown in the figure. Curve B gives direct measurements of electromotive force. The other curve shows Dieterici's[1] measurements of vapor pressure at 0 degree. But as the process of calculating electromotive force from this is not a satisfactory one, I have reversed it and calculated the vapor pressure from the electromotive force; the results are shown by small crosses near the vapor-pressure curve. The vapor pressure for $z = 0.05$ is assumed. It will be seen that the other points lie near the curve of observation, but the agreement leaves something to be desired.

The curve of free energy follows that of total energy in its general course. The difference between the two represents, as is well known, the "latent heat" of the cell, or, otherwise stated, the term $T\frac{dE}{dT}$; it is consequently a measure of the temperature coefficient of this cell; this is positive over most of the range, but negative for very dilute acid, and zero for $z = 0.006$. For that concentration alone the free energy is equal to the total energy. This point was determined by Dolezalek by direct experiment, as $z = 0.012$. Here, again, though the experiments support the theory in a general way, the agreement is not quite what might be hoped for if the constants of sulphuric acid solutions were systematically redetermined.

APPENDIX.

If Ω is the change of free energy corresponding to the reaction (in equivalents)—

$\frac{1}{2}Pb + \frac{1}{2}PbO_2 + H_2SO_4 = PbSO_4 + H_2O$,

when undiluted H_2SO_4 is used; and if W is the free energy of formation of the mixture $z\ H_2SO_4\ .\ (1-z)\ H_2O$, then the change of free energy due to the above reaction when taking place in a solution of strength z is $\Omega - \frac{dW}{dz}$.

The electromotive force E of an accumulator is therefore found by dividing this quantity by the "faraday" F (= 96,600 coulombs), or

$$E = \frac{1}{F}\left\{\Omega - \frac{dW}{dz}\right\} \quad . \quad . \quad . \quad (1)$$

Now $\frac{dW}{dz}$ may be found in terms of vapor pressures as follows:

Given one molecule of mixture of strength z, and a small quantity of dz molecule of H_2SO_4, mix these, and remove from the mixture dz molecule of H_2O. We have then obtained one molecule of mixture of strength $z + dz$, or in chemical symbols—

$$z\ H_2SO_4\ .\ (1-z)\ H_2O + dz\ H_2SO_4 = (z+dz)\ H_2SO_4\ .\ (1-z-dz)\ H_2O + dz\ H_2O.$$

The change of free energy in this reaction is therefore $\frac{dW}{dz}$. To evaluate it, suppose the acid added and water removed reversibly by isothermal distillation.

Let p_o p be the vapor pressures of pure water and of water in the given mixture respectively.

p'_o p', the vapor pressures of pure sulphuric acid and of sulphuric acid in the given mixture respectively.

R, the gas constant.

T, absolute temperature.

Then it is well known that—

$$\frac{dW}{dz} = RT\left\{\log_e\frac{p'_o}{p'} - \log_e\frac{p_o}{p}\right\} \quad . \quad . \quad (2)$$

Hence,

$$\frac{d^2W}{dz^2} = RT\left\{\frac{d\log_e p}{dz} - \frac{d\log_e p'}{dz}\right\} \quad . \quad (3)$$

But in virtue of the thermodynamical relation[1]—

$$z\frac{d\log_e p'}{dz} + (1-2)\frac{d\log_e p}{dz} = 0 \quad . \quad . \quad (4)$$

We may eliminate from (3) the vapor pressures of sulphuric acid, which are too small to measure, and obtain—

$$\frac{d^2W}{dz^2} = \frac{RT}{z}\frac{d\log_e p}{dz},$$

or, from (1)—

$$\frac{dE}{dz} = -\frac{RT}{zF}\frac{d\log_e p}{dz} \quad . \quad . \quad . \quad . \quad (5)$$

This equation may be made use of either to determine E from p, or p from E; but, in practice, allowing for the difficulty of obtaining trustworthy empirical formulæ, it is the latter that is more satisfactory. For this purpose we may write:

$$\log_e p = -\frac{F}{RT}\int z\frac{dE}{dz}\,dz.$$

Direct evaluation of this integral involves the impracticable practice of obtaining differential coefficients of the observed electromotive forces. It is therefore necessary to integrate by parts:[2]

$$\log_e p = \frac{F}{RT}\left\{\int E\,dz - Ez\right\}.$$

The results given in the text and accompanying plates have been obtained graphically from data given by Dolezalek;[1] they are given in terms of the cadmium cell as 1.0220 volts. I have therefore reduced them in accordance with more recent determinations of the standard cell as being 1.0187 volts. Thus reduced they are:

z	E
$\frac{1}{101}$	1.881
$\frac{1}{21}$	2.001
$\frac{1}{11}$	2.096
$\frac{1}{6}$	2.245

A Simple Oscillograph.

The oscillograph is a useful instrument for studying the phenomena of alternating currents, but, unfortunately, the instruments perfected by Blondel and Duddell are too expensive to come into general use. The *Electrical Engineer*, of London, describes a simple oscillograph devised by A. Wehnelt, which is not expensive and which has been used successfully for ordinary frequencies. The vibrating part of this instrument is formed of a loop and hard-drawn silver wire supporting a mirror. The two sides are parallel and from two to three millimetres apart. When a current is passed through this wire with the magnets excited, the mirror is deflected to an extent approximately proportional to the current strength, the apparatus acting as a D'Arsonval galvanometer. If the current varies periodically, instantaneous deflections will still be proportional to the instantaneous current values, provided that the natural period of the moving system is very short compared with the period of the current, and also that damping of the system is very great. By employing a powerful magnet and a tightly stretched wire, both these conditions may be fulfilled. The wire is mounted on ebonite, with a tightening arrangement which allows the amplitude curves to be varied at will. A small three and one-half ampere arc lamp is used as a source of light, the beam being rendered parallel by means of a lens. For lecture purposes a revolving mirror throws the curve on the screen, and by a simple arrangement of two of these instruments, both the current and electromotive-force curves can be shown simultaneously, and the effect of varying the constants of the circuit is plainly demonstrated. This apparatus can be used if the periodic time of the change to be considered is not less than 0.01 second, as the natural time of swing is 0.003 second. In the Duddell oscillograph this is only 0.0001 second.

[1] *Wied.*, 50, 61.

[1] For the history of this relation, see Ostwald *Lehrb. d. Allg. Chemie*, Vol. II, p. 688.

[2] Lehfeldt, *Phil. Mag.*, April, 1901.

[1] *Theorie des Bleiaccumulators*, p. 33.

AN INTERESTING FOUNDRY DEVELOPMENT.

THE LIBERAL USE OF ELECTRIC MOTORS AFFORDS CONSIDERABLE ECONOMY IN HANDLING RAW MATERIAL AND CASTINGS.

In any line of industry it is one thing to modernize by building all new works where the latest improvements may be readily incorporated and provisions for expansion allowed, but it is quite another matter to keep an old plant abreast of the advancing times and its facilities adequate for the increased demands upon its producing capacity. The foundry of Messrs. Maher & Flockhart, in Newark, N. J., is an example of a success in the latter class, for while it had its beginning in a small way, with only such means as that time afforded, it is to-day employing about 400 men and conducting a large business on a profitable basis, due to the fact that the owners are alive to the advantages of improved methods and perfected machinery.

The original works, erected in 1882, occupied a space about 100 feet square, on the corner of Polk and Clover streets, Newark, N. J. Since that time they have been extended on all sides until they now cover an area of two and one-half acres, the regular layout of which is shown on an accompanying plan. The apparent lack of system in the arrangement of parts was the unfortunate but unavoidable consequence of this bit by bit growth. Each addition was made in what was considered at the time the most advantageous manner, although the outcome as a whole has not proved all that could be desired. However, the disadvantages of the worst locations have been largely removed by installing conveying appliances both out of doors and in, in the shape of industrial railway tracks and communicating cranes.

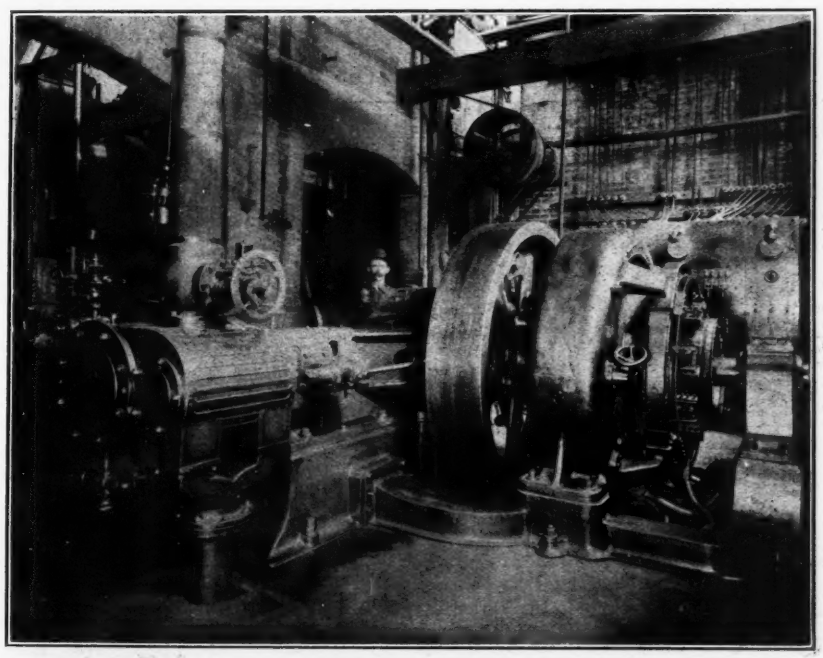
One of the neatest features contributing to convenience is the scheme for delivering supplies into the yards by freight. The tracks of the Central Railroad of New Jersey pass close to the grounds and being elevated to avoid grade street crossings through the city were easily connected with two spur trestles which branch into the yard. Beneath the trestles are numerous storage bins into which the contents of the cars may be dumped directly, giving a selective distribution and requiring no handling of the material until it is needed for use. Under the trestle terminating near shop No. 2 are bins for the following: Jersey clay for clay-wash; kaolin for furnace and ladle linings; sand for sand-blast; soft coal for the boilers; coke and pig iron. The other line of bins is used to store stove coal for the core ovens; soft coal for the boilers; Jersey sand for dry-sand work; fire sand; Albany sand and Waterford sand for green sand moulds. There are also two narrow bins, or chutes, secured on the outside

EXTERIOR VIEW OF THE MAHER & FLOCKHART FOUNDRY, NEWARK, N. J.

of the larger ones, which are used to hold pea-coal and flour. A sufficient stock of coal, sand, etc., is always carried in storage to cover a period of four months and avoid shutting down for anything but a prolonged failure to receive supplies.

Shops Nos. 1, 2, 3 and 4, indicated by those numbers on the plan, are the largest buildings, and constitute the foundries. Foundry No. 1 produces all of the largest castings, some of them weighing as high as fourteen tons; No. 2 is used only for small castings, and No. 3 provides for intermediate sizes up to two tons. Primarily No. 4 was intended for a cleaning shop, but it has been necessary of late to utilize it also as a foundry for castings under eight tons in weight. The remainder of the buildings include the engine and boiler plant, machine shop, numerous cleaning rooms, core rooms, pattern shop and storage rooms, stables, etc.

The engine and boiler plant, located near the centre of the group, though one of the smaller parts, is nevertheless of prime importance, since it is the source of power upon which all else is dependent. The rooms are side by side, separated by a brick wall. In the boiler room are two Coatesville tubular boilers; one of 150 boiler-horse-power is seventy-two inches in diameter, nineteen feet long, and contains 100 three and one-half-inch tubes; the other has a capacity of 125 horse-power, is sixty-six inches in diameter, nineteen feet long, and contains 100 three-inch tubes. A forty-inch sheet-iron breeching conveys the gases of combustion from the boilers to the base of a stack of the same material and diameter, 108 feet high. Steam is generated at a pressure of 100 pounds and conveyed by short lines to the steam-consuming apparatus, all of which is located in the adjoining room, consequently there is very little lost by condensation in the steam piping.



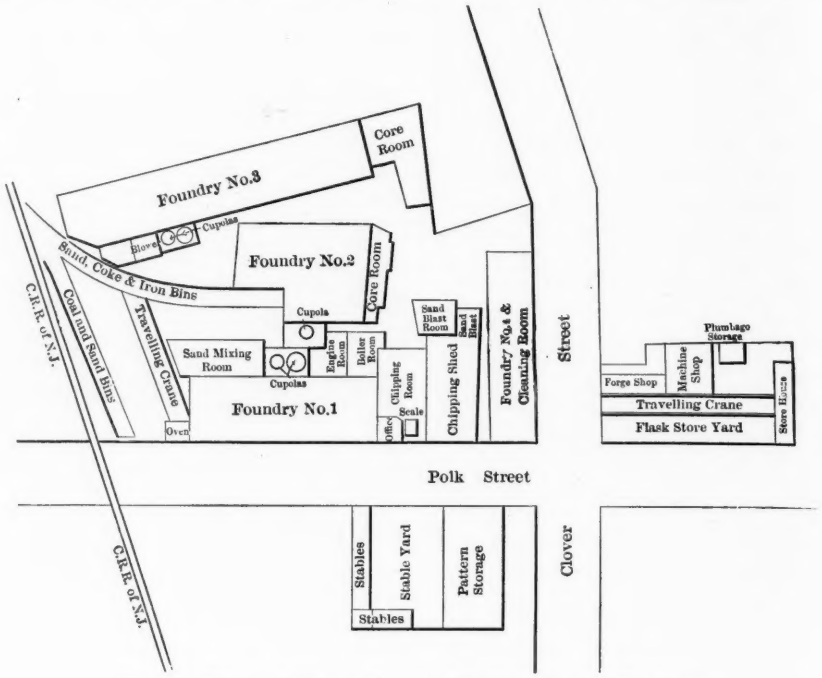
VIEW IN ENGINE ROOM, SHOWING HARRISBURG ENGINE DIRECT-CONNECTED TO A CROCKER-WHEELER GENERATOR.

The engine room contains two steam-driven air compressors; a Harrisburg standard horizontal high-speed fifteen and one-half by sixteen-inch engine, direct-connected to a Crocker-Wheeler 100-kilowatt direct-current generator; and a thirteen by twelve-inch, 150-horse-power Ball

engine, running at 275 revolutions per minute, and driving a line shaft from which are belted a Benjamin F. Kelley & Son duplex, single-acting, six by six-inch boiler-feed pump; a Crocker-Wheeler thirty-kilowatt, compound-wound, 125-volt generator, running at 800 revolutions per minute; an Ingersoll-Sergeant eight by eight-inch, double-acting air compressor, at 125 revolutions; and a B. F. Sturtevant No. 9 horizontal bottom-discharge blower. A No. 8 Sturtevant blower, belt-driven by a Crocker-Wheeler forty-five-horse-power motor, completes the apparatus found in the engine room. This blower provides forced draft for the cupola which supplies foundry No. 2, and the No. 9 blower serves whichever furnace is in operation in foundry No. 1. The Ingersoll-Sergeant and one of the steam-driven compressors, a Clayton ten by ten by thirteen-inch pump running at 150 revolutions per minute, both deliver into a three by six-foot cylindrical tank, which supplies all pneumatic hoists, shipping tools, etc. A pressure governor on the steam supply of the Clayton compressor automatically maintains the pressure within the tank at about eighty pounds, while the belted compressor runs continuously. Similarly the boiler-feed pump is in constant operation, it having been found cheaper to short-circuit the cylinders when the required water level

No. 2 Foundry for Small Castings.

in the boilers is reached than to provide for stopping and starting attendance. This is accomplished by an automatic by-pass which allows the water to surge back and forth between the alternately acting cylinders at a small waste of power, the speed being but eighteen revolutions per minute. In case the pump becomes disabled the boilers may be fed by an injector.



Plan of Foundry Works, Showing Distribution of Buildings.

City water is used for the feed as the water from the artesian well under the engine room is unfit for that purpose. The latter is raised from the well by steam or air pressure through a Watson deep-well ejector to a 3,000-gallon tank on the roof and is used in the foundries for clay washes, sand wetting, etc.

On bright days, during the forenoon hours, the small belted generator is capable of carrying the entire electric load, but in the afternoon, when the furnaces are in operation, it is necessary to run the direct-connected set. This has a capacity of 100 kilowatts at 125 volts and a speed of 250 revolutions per minute. An accompanying cut shows the set and the switchboard controlling the electric light and power distribution.

The other steam-driven air compressor is used to supply two sand blasts for cleaning castings, and was manufactured by the Franklin Iron Works, of Port Carbon, Pa. It is double-acting, with steam cylinder twelve inches in diameter, air cylinder sixteen inches, and stroke sixteen inches long. It runs normally at eighty-two revolutions per minute and supplies about 130 cubic feet of air per minute at a pressure of twenty pounds to the square inch.

From the engine room the main line shaft extends over the boilers into the chipping and grinding room, where it drives three double emery grinders, and continuing still farther belts to two tumblers and a Root exhaust fan. The chipping room is one of several where the finished castings are cleaned and trimmed, both hand and air chisels being used. The tumblers, which were but recently installed, are thirty-six inches in diameter by forty-eight inches long, and are of an enclosed pattern manufactured by the W. W. Sly Company, of Cleveland, Ohio. Unlike the old style, which allowed the dust and dirt to sift through perforations and settle where it would,

these are devoided of their dirt by an exhaust fan connecting with an enclosed elevated bin. From time to time the accumulation in the latter is dumped through a gate at the bottom into cars and removed.

Interior of No. 1 Foundry Where the Largest Castings Are Made.

In the opposite direction the engine room line shaft is extended into the furnace room off foundry No. 1, where it is belted to a freight hoist used in charging the three adjacent cupolas which serve foundries 1 and 2, and also to a No. 6 Buffalo blower. This is used in connection with a special process for baking large dry sand moulds without the use of an oven, that is said to accomplish the work in less than half the time required in oven baking. The blower discharge is piped under ground to a convenient fixed point near the centre of the foundry and from this a temporary pipe connection is made to the mould to be baked. A fire is built in a rectangular sheet-iron stove, placed on top of the mould, through which the air is passed just before it enters the runner. The hot air is thus delivered to all parts of the mould in the most even manner possible, and being under pressure dries out the moisture very rapidly.

The engine room line shaft also drives a long shaft in foundry No. 1, furnishing power by cross belts to three jib cranes, having capacities of ten, twenty and fifteen tons respectively. These were manufactured by the Farrel Foundry and Machine Company at Ansonia, Ct., and are arranged in a line through the middle of the shop as close together as possible without interfering with one another. In addition there are three hand-power jib cranes of four tons capacity each, two on one side of the shop and one on the other, placed so that they will reach to the larger cranes. The shop is 192 feet long by fifty-three feet wide, but every part of it, except the extreme corners, is accessible to one or another of these six cranes. As before stated, there are two cupolas to this shop. The older one, a fifty-six-inch Colleau furnace, melting from five to seven tons an hour, is seldom used now except in slack seasons. The new one was furnished by the Whiting Foundry Equipment Company, is seventy-two inches in diameter and will melt between ten and twelve tons an hour. For the baking of dry sand moulds and cores there are six ovens, the dimensions of which are interesting as showing the quantity and size of the work which may be baked at one time. All are sixteen feet deep; one is ten feet wide and nine feet high, the rest are eight feet high, one being twelve feet wide, two seven feet wide, and two eight feet wide. Each oven has an iron car running on rails which receives the charge to be baked from the cranes and is then rolled inside. A baking lasts overnight, about twelve hours, the average temperature during that time being about 220 degrees Fahrenheit. To supply the heat a fire is built in the pit at the rear of each oven, using enough coal to last about eight hours. For the rest of the time there is very slight loss of heat until the doors are opened in the morning.

The shaft in this foundry is belted through the wall to two sand mixers in the adjoining core and sand room. One of these is a slowly revolving screen for mixing and sifting the ingredients for the dry sand work. The other is a Sellers horizontal, centrifugal, green sand mixer and runs at about 1,000 revolutions per minute. Another dry sand mixer is located near shop No. 3 and is driven by a

Foundry No. 3 for Medium Size Castings.

five-horse-power Crocker-Wheeler enclosed motor.

The small casting foundry No. 2 has about 7,500 square feet of floor space, exclusive of core and furnace rooms. Cranes are not needed here; instead there is an overhead track and trolley system extending around the room for conveying large ladles from which the smaller hand ladles are filled. The cupola is a fifty-six-inch Whiting, having a capacity of about six tons an hour. Much of the work done in this shop consists of large quantities of castings from the same pattern and for this several moulding machines are used, each where skilfully handled is capable of turning out from two to twenty moulds an hour, depending on their size.

Foundry No. 3 is 177½ feet long by sixty-seven and one-half feet wide with a line of pillars down the centre, and each half served by two four-ton traveling cranes. One is an electric crane with Crocker-Wheeler motors. At present the other three have hand-travel and pneumatic hoists, but these are soon to be equipped with electric travel to increase the speed of handling, and electric hoists on account of the poor efficiency of air hoists and the difficulty of keeping the necessarily long lines of rubber hose in repair. Two cupolas serve this foundry, one being a seventy-two-inch Newton, built by the Northern Engineering Works, of Detroit, Mich., and the other a fifty-six-inch Whiting. But one is used at a time, the choice depending upon the amount of work on the floor. The blast is furnished by a Root rotary pressure-blower, driven at 100 revolutions per minute by a Crocker-Wheeler thirty-five-horse-power open-type motor, and a direct-acting pneumatic lift is used for elevating coke and iron for charging the furnaces. There are three ovens similar in construction and operation to those in shop No. 1. Two are eight feet wide by eight feet high by twelve feet deep, and the other is ten feet wide with the same height and depth.

Shop No. 4 is thirty-seven feet wide by 154 feet long and contains two electric traveling cranes, one of ten tons capacity, installed by Pawling & Harnischfeger, of Milwaukee, and one of five tons capacity, put in by the Cleveland Crane and Car Company and operated by Crocker-Wheeler crane motors. Whenever any casting is done in this shop the metal is brought in a large ladle car from No. 1 foundry. The system of tracking, laid on a gauge of forty inches, connects all parts of the works, even crossing Clover street, as shown on the plan. The cleaning shop beside No. 4 is well fitted to handle moderate-size work rapidly. It is divided longitudinally and has two hand-power cranes of 3,000 and 6,000 pounds capacity respectively, serving one-half, and a 4,000-pound electric traveling crane, controlled from the floor, serving the other half.

A small but indispensable part of the plant is the machine shop on the other side of Clover street. Although it is in an out-of-the-way place, this disadvantage is more than compensated for by the conveying facilities already described and the absence of dust and dirt making it easier to keep the machine tools clean and in good shape. Alongside of the machine shop is a yard for the storage of idle flasks. To handle the heavier flasks there is a hand-operated traveling crane in the yard, which is also of service in passing machinery to be repaired to the four-ton hand crane in the machine shop. The tools in the shop include a Pennsylvania drill press, a twenty-six-inch Prentiss back-gear crank-shaper, an F. E. Reeden ten-inch lathe with a fourteen-foot bed, a Bickford forty-eight-inch radial drill, a forty-eight-inch by twenty-foot planer, a twenty-inch Pond lathe with a twelve-foot bed and a Sanderson bolt and screw cutting machine, taking stock up to three inches in diameter. Power is provided through line shafting by a fifteen-horse-power Crocker-Wheeler shunt-wound motor, running at 1,200 revolutions per minute. Since the plant is operated strictly as a foundry and does not presume to contract for outside machine work, this shop is ample in size and equipment for its purpose, *i. e.*, the keeping of the mechanical features in the best possible condition by providing repairs and improvements whenever they are demanded.

BOOK REVIEW.

"Engineering Preliminaries for an Interurban Electric Railway." Ernest Gonzenbach. New York. McGraw Publishing Company. Cloth. 6 by 9 inches. 71 pages. 6 diagrams. Supplied by the ELECTRICAL REVIEW at $1.

This little volume is a preliminary report, probably being an augmented transcription of an actual report covering the conditions as given in the text, on a prospective interurban electric railway, sixty-two miles in length. This is a feeder for a large manufacturing city and serves several towns and hamlets, the largest having a population of 21,000 and being one terminus of the road. It shows judgment, experience and common sense in the matters of selection of system, schedule, character of service and in fact nearly every subject included in the report. As stated in the introduction, it is not a general work covering all conditions, but there is much good advice in the book that is applicable to other classes of electric railways. The method of arranging the schedule is ingenious and apparently practical; the comparison between the third rail and trolley fairly made and the result convincing. The dominant note that runs through the whole report is the necessity for breaking away from the precedent set by city street railways, and designing interurban roads on entirely different lines—a sensible and wise opinion. There are a few points which, however, would seem to be open to criticism. For instance, sixty inches apart seems an unnecessarily great distance to separate the wires of a three-phase transmission line sixty-two miles in length (the station is for good reasons at one end of the line); also the road is to cost $1,963,750, and the proposed bond issue is $2,000,000 of five per cent. Therefore, to merely build the road these bonds must sell at par, and when underwriting companies pay par for five per cent bonds on an interurban electric road, paralleled by a steam railway, the millennium will have come. The price of $120 per kilowatt for power station equipment, exclusive of buildings, seems about $45 too high. Good stations of the character mentioned can be easily built for $75 per kilowatt. As a report, it is too lengthy and wordy for a financier who has no technical knowledge to wade through, though, as before stated, the original report has no doubt served simply as the basis for this book, and the reasoning and detail which appear, while objectionable in a regular report, are here necessary to make the work helpful. Of especial importance is Mr. Gonzenbach's insistence for heavy ballast and plenty of it, for block signals and for proper accommodations for the passengers, both as to rolling stock and waiting rooms. The total cost per mile of the equipment specified is $29,750, a figure which is justified by the various considerations set forth. This book is a fine example of a preliminary report and worthy of the careful attention of any electric railway engineer.

In the Moebius process of refining silver, the metal is deposited from a solution of its nitrate by a heavy electrical current, coming down in the form of loose crystals, which are brushed off the cathode and caught on muslin trays. The process is a commercial success.

Technical Education in the United States.[1]

Early this year it was decided by the governing body of the Northampton Institute that it was desirable, in view of the expected rapid developments of the day classes in engineering, for the principal to make an educational tour in America for the purpose of investigating the present conditions of higher engineering education there and its relation to the various industries for which students are being trained. This trip was made during the spring of this year, and the results of the investigation are given in this preliminary report.

Early in the investigation it became evident that the most important part of the enquiry, and that calling for the greatest attention, was the ascertaining of the views of employers and manufacturers on the products, in the shape of graduates, turned out by the engineering colleges and schools. This point was kept well in view throughout the tour.

The results of the enquiry are, for convenience, divided into four classes, according as they relate to the students, to the colleges and schools, the subsequent careers of the students, and the views of employers and manufacturers, as well as others competent to form valuable opinions on the work carried out and its bearing and effect upon the industries and manufactures of the country.

STUDENTS.

Enquiry being mainly directed toward the higher engineering education, the students chiefly referred to will be those who enter the engineering faculty of the university or the day classes of a polytechnic or technical institute with a view to graduating as engineers. These students are mainly drawn from youths who pass through the high school course or its equivalent. They are usually ready at eighteen years of age to enter the university or the technical college and complete their training in a further four-year course.

It would perhaps be supposed that the students who, from fourteen to eighteen years of age, take the manual training course would be better prepared for engineering training than those who take the more general high-school course. Educationalists, however, are by no means agreed upon this point, many holding that the high school provides better material for subsequent professional work. This adverse opinion with regard to the manual training schools is probably due to the fact that some of them are not content to prepare for the higher engineering courses in the universities and technical colleges, but encroach on the domain of the latter, with the result that, attempting too much, the students are badly grounded and their knowledge is superficial.

When the student enters the college he is older than the corresponding student in England, and his general education, on the average, has been carried to a higher point. He is therefore better equipped to take advantage of the training offered by the professional school. Not but that the better or even the average pupils turned out by some of our best and most modern English schools at sixteen and one-half or seventeen years of age are as well trained as the older graduates of the high schools in the United States. On the other hand, owing to the chaotic state of secondary education in England, vast numbers of pupils fifteen years old and upward annually leave the secondary schools with their education "finished," who, in the United States, would not be qualified to pass out of the grammar school.

To sum up, the students taking up a collegiate engineering training from the secondary schools can be counted in hundreds, as compared with tens or less in England. They enter the colleges at a later period of life and are better prepared, on the average, for the work.

In addition to these students there is a fair average of older students, consisting of men who have been obliged, through various circumstances, to start practical wage-earning life at an early day, and who have saved the necessary money and returned to school discipline and training with very definite objects in view, and not infrequently become the most successful of the engineering students. This is because they are men endowed with the determination to make their way, and they form a most useful leaven in giving a tone of earnest work to the school.

THE COLLEGES AND SCHOOLS.

These consist of the various colleges and schools of engineering, the numerous state and other universities, and also of certain technical institutes which devote themselves largely, if not exclusively, to engineering education. Generally the curriculum occupies four years. The first two are devoted to an ordinary scientific training in mathematics, chemistry and physics, though often subjects of general —as distinct from professional—educational value are included, and sometimes mechanical drawing, which is distinctly professional, is added. Frequently in these two years a certain amount of time is given to workshop practice. With these exceptions, the actual engineering training does not commence until the third of the four years, and in many cases even in this year a certain amount of time is devoted to non-professional subjects. In the last year of the four a crowd of professional subjects is introduced, with the result that, in many cases, the student is unable to assimilate all that is placed before him, especially as a certain amount of time has almost invariably to be given to a graduating thesis, without which he can not obtain the coveted diploma.

In regard to the length of time occupied, the opinion in the United States, is divided, but many who have carefully studied the subject hold strongly that the period is too short for the training which is attempted, and that another year of professional study should be added before the graduate is sent out to practical work. In some cases this opinion has been carried into effect.

Turning to the buildings in which the schools are housed, and the equipment of the laboratories and workshops, we find still greater differences from the conditions obtaining in England. In none of the institutions of higher engineering education visited was there less than one large building solely devoted to engineering. In most cases, besides one large building, there were two or more additional buildings for special laboratories and workshops. To one accustomed to the similar provision made in England, the accommodation provided seems at first to be lavish; but in many cases, on enquiry, it was found that those responsible for the work deemed the provision inadequate. The great expansion that has taken place is of comparatively recent growth. Many of the buildings have been erected in the last ten years, so that in this respect England is not so far behind in point of time if it will only face the necessary cost. Certainly, no time is to be lost. It may perhaps be argued that the equipment in the United States is too lavish and much of the money spent on palatial buildings might have been employed for more utilitarian purposes. At any rate, the money for buildings—architecturally splendid in many cases—has been readily found, and this fact alone may justify the expenditure. The further fact, already mentioned, that in many cases extensions are being pushed forward may be taken to answer—though not completely—the other assertion of too lavish equipment. The net result is that

[1] Abstract of the report of Principal R. Mullineux Walmsley, of Northampton Institute, England, on his American tour.

in the best of the schools the student in his third and fourth year handles machinery and apparatus of the latest and most up-to-date pattern and of a size adequate to elucidate the principles and solve problems on an engineering scale. Moreover, owing to the attitude of manufacturers, contractors and others, the student frequently has opportunities of testing and experimenting with a much larger plant in actual operation outside of the school, and thus, both inside and outside, is brought face to face with problems in a manner which will recur when he takes up the real business of engineering life.

The staff of an engineering college is one of the most difficult problems which has to be faced. It is absolutely essential that each of the members should have had practical commercial experience in the particular branch of the subject he is called upon to teach, and it is more than desirable that he should also be a trained teacher. The two conditions, in most cases, are incompatible, for the man who has given sufficient time to practical commercial work to suit the first requirement has perforce had little or no time to devote to training. On the other hand, the man who possesses the necessary practical experience has a value outside of the college which is not paralleled in literary and other branches of education. Moreover, even in the subjects that are not distinctly professional, such as mathematics, physics and chemistry, it is usually, though not so widely, deemed desirable that the teacher should have practical engineering experience. It follows from the above that for the most suitable kinds of teachers in engineering, the colleges will have to compete with the open market in a manner which does not obtain in most branches of education.

It is universally the custom in the United States, not only to give the engineering professors opportunities for outside work, but to require that they shall actually undertake such work, so as to keep themselves abreast of the various lines of progress in the profession. However, many hold that the colleges can not and do not attract the right class of teachers, except in a very few special instances, and that they should bid higher if the education offered is to be of the right kind. The general conclusion is that the colleges, on the whole, are staffed with good men, but there is still room for improvement and that this can only follow by still further raising the remuneration of teachers.

THE SUBSEQUENT CAREERS OF THE STUDENTS.

It was found that the attitude of employers toward the graduates of colleges and technical schools was not the same in all cases. On the whole, it may be said that not only do the employers view with favor applicants for employment who can produce the graduation certificate of the engineering department of a university or of a technical school, but that many go further than this and will not accept as apprentices for their technical staff any man who can not produce such a certificate. All the employers offer a living wage at the start of the service and do not charge any premium. In fact, the premium apprentice appears to be unknown in America.

After having gained admission to the profession by entrance in a works or obtaining some other position at a living wage, the subsequent career of the college graduate depends, as a rule, upon himself far more in America than in England. It is very freely asserted that outside influence is not permitted to push forward less competent men to the detriment of more competent ones. Special enquiries on this point confirm this assertion. As a rule the competent graduate rises quickly, and at the end of the first six months finds himself advanced to a more highly paid position; and within two years from leaving college, the best of the men occupy well paid and responsible positions.

During the first two or three years after leaving college there is a considerable rearrangement of the relative positions of the graduates. It may, however, be said that, on the whole, even the mediocre men obtain good positions on the commercial, if not on the scientific side of practical engineering, and that the best men rise very rapidly to excellent positions.

VIEWS AND ATTITUDES OF EMPLOYERS.

Briefly, it may be said that the most important manufacturers and employers regard the work done in the colleges as being of material and vital importance and absolutely indispensable to the development and progress of engineering industry. More than one captain of industry enlarged upon the necessity of an adequate supply of trained and disciplined brains as being essential to the prosperity of his firm, and many expressed themselves as prepared to do anything within reason to ensure the continuity of such a supply. The moral influence of this attitude of the employers toward the schools is of great value in directing the attention of parents and guardians of the youths who desire to be engineers, to the necessity of college training and its bearing upon their subsequent prospects of success.

There is, however, a minority of employers and other practical men which does not agree with this opinion. Even those favorably disposed sometimes freely criticise important details, either of methods, equipment or staff. One important point on which it seems almost impossible to obtain any consensus of opinion from the employers is as to the value of the school workshop training, the extent to which the methods of commercial workshops should be copied, and the position a workshop should take and the amount of time which should be devoted to it in training. The most generally expressed opinion is that the schools should not attempt to copy too closely the commercial workshops, for in so doing they run the risk of leaving too little time for other important matters with which they are more competent to deal. But the most modern workshop methods should be brought to the notice in a practical form, especially those methods which tend toward cheapness and accuracy in production.

MANUAL TRAINING SCHOOLS AND TRADE SCHOOLS.

The report also takes up manual training schools and trade schools. It is not thought that the results obtained by the manual training schools are satisfactory. The schools are staffed with men trained as schoolmasters and not as engineers. They attempt to cover too much ground, and the graduates are not as well prepared to enter the technical courses of colleges as graduates from the high schools. On the other hand, these schools do not form a good source of supply for bench hands, gang bosses and foremen, for their graduates are unwilling to commence low down enough in the factory to make good machinists and fitters.

At the trade schools which were inspected the students are taught the various trades by practical work. Little or no general education is given and, on the whole, such schools which aim at but little beyond a place in an ordinary commercial workshop are not recommended.

The Republic of Paraguay to Subvention Engineering Students.

On July 3, 1903, the Congress of the Republic of Paraguay passed a law authorizing the president to subvention five young men to the amount of $65 gold each per month, for the purpose of carrying on their studies in engineering at some university in Europe.

NOTES ON CERTAIN THREE-WIRE SYSTEMS.[1]

CHAS. T. MOSMAN.

The present tendency in electrical developments is toward the serving of large districts from large central stations. This tendency naturally leads to alternating-current distributions for light and power where under other conditions direct current might be used. The new work of to-day is thus largely alternating, or alternating converted to direct current for final distribution.

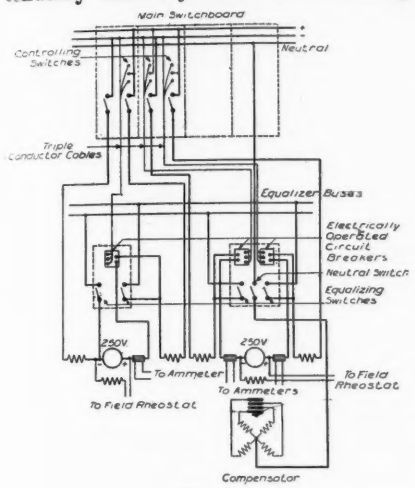


FIG. 1.

Existing direct-current installations are continually expanding, and many are being adapted to receive power from large alternating-current stations. It is necessary to carefully consider the new conditions to be met and the various methods and apparatus with which to meet them, before placing orders. New plants of a more or less isolated character may be best served by direct current, although where there is any doubt as to which is advisable it is well to give the alternating current the preference on account of the ease with which such a system is extended. A discussion of direct-current systems in general would be an undertaking of large dimensions, hence I will bring to your attention but one or two points which may prove interesting.

The direct-current lighting and power work of to-day in this country is principally three-wire. The advantage of the three-wire system lies in the transmitting voltage being twice that of the receivers, hence upon the advent of the 250-volt incandescent lamps it was natural to expect an extensive adoption of a 500-volt three-wire system, this system having the added advantage of enabling duplicate generators to serve light and power and railway. The 500-volt three-wire system is particularly applicable to manufacturing plants using electricity principally for power, with incidental lighting, and to central stations serving a comparatively scattered load within a somewhat limited radius.

A comparison of 250-volt and 500-volt underground three-wire systems will show that the superiority of one over the other depends upon the density of the load, the proportion of the total load that is incandescent lamps, the size of the motor units connected to the system, the cost of producing additional power and the cost per kilowatt of the generating equipment. In large cities served by a central generating station and many substations containing converters for supplying the three-wire network, the load is quite dense, and it can be shown that in many cases the savings in copper and number of substations, due to the higher voltage, is more than offset by the increased power required by the high-voltage lamps.

The lower the density of the load, the lower the proportion of incandescent load

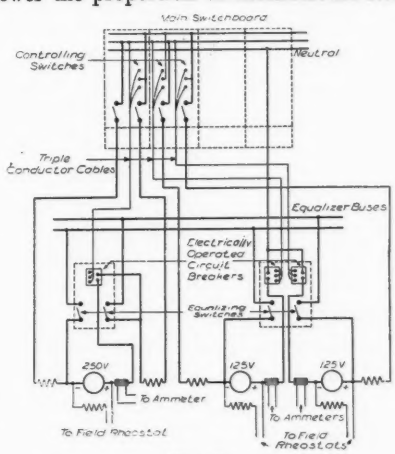


FIG. 2.

at the total load, and the lower the cost of power and generating apparatus, the greater becomes the advantage of the 500-volt three-wire system.

The 500-volt system is at a disadvantage due to the higher cost of arc lamps, meters, fan motors, incandescent lamps, cutouts, rosettes, circuit-breakers, etc., the prices being higher in approximate accordance with the accompanying table.

Article.	Per Cent Higher Price.	
Incandescent lamp....	11	3.8 watts per c.p.
Incandescent lamp....	25	3.4 watts per c.p.
Arc lamp	33⅓	2 in series
Arc lamp	50	twin carbons
Wattmeters	30	3 wire
Wattmeters	0	2 wire
Cabinet panels.....	5	
Circuit-breakers.. ...	25	D.P. 500 volts
Switches.....	0	D.P. 250 volts
Switches.....	75	D.P. 500 volts
Fan motors	10	250 volts
Rosettes.....	7	250 volts
Fuse plugs.....	60	250 volts
Snap switches.....	0	250 volts
Lamp sockets.....	0	250 volts

Two hundred and fifty-volt incandescent lamps may be obtained of 3.8 and 3.4 watts per candle-power, having the same useful life and candle-power area as the 3.1 watts per candle, 125-volt lamp.

Arc lamps may be connected two in series at the disadvantage of comparatively complicated wiring and the necessity of burning two lamps when one only is required, or a twin carbon lamp may be used at the disadvantage of a more complicated mechanism and probable high maintenance cost. A single-carbon, 250-volt lamp gives an objectionably purple and unsteady arc. This excess of purple rays necessitates the use of denser globes than those used with 125-volt lamps, in order to produce the same quality of light.

A decision in favor of a 500-volt three-wire system should not be made without first giving due consideration to alternating current. The advantages of continuous current over alternating are mainly the following:

First—The possibility of the use of storage batteries.

Second—The possibility of operating high-speed passenger elevators direct from the lighting distribution.

The efficiency of a storage battery is low and the maintenance usually high. For these reasons it can not always be considered an economical investment. Storage batteries may, however, be considered essential for the power service of a dense business district, on account of their value in supplying sudden demands for current due to summer showers or a breakdown or burning off a short-circuit in an underground system. They are

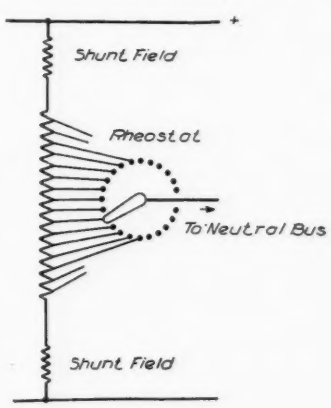


FIG. 3.

also of great value in maintaining good regulation.

The induction motor with collector rings and variable external resistance will give good results on all but the higher speed elevators. A district in which a 500-volt three-wire system is particularly applicable would probably not contain any

[1] Paper read before Ohio Electric Light Association, Columbus, Ohio, October 13, 14, 15.

high-speed elevators; such a district could well be served by alternating currents, using possibly a separate power circuit. A city of 100,000 inhabitants would probably have a dense business section containing high-speed elevators, and large

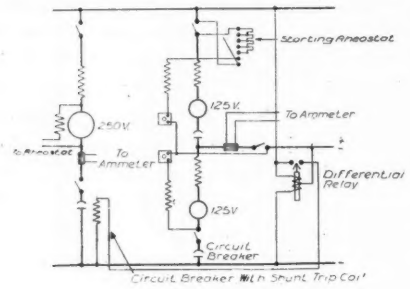


FIG. 4.

residence districts having a comparatively light scattered load. Such a city may be served by a three-phase generating system, a three-wire network, using high-efficiency 125-volt lamps, and fed by single-phase primary feeders, being used for the business district; the power load of which is carried by a 500-volt, direct-current power circuit fed by rotary converters or motor-generator sets. Three-phase feeders should be run through the residence districts, the lighting load being carried on one phase only, the third wire being run into such districts as offer light power load.

The large cities contain extensive districts where the load is of such density that the 250-volt three-wire system with high-efficiency lamps is most suitable. They also contain large suburban districts which may be best served by alternating current. A combined continuous-current and alternating-current generating system with rotaries or motor-generators to connect the two is well suited to such cities. Chicago, Boston, Philadelphia, Cleveland, Toledo and Columbus may be mentioned as examples of such an arrangement.

There are many cities which might be well served by an alternating-current system, which have had a three-wire direct-current system in operation before the advent of large alternating central stations, and the systems have assumed such proportions as to preclude all consideration of alternating currents for the denser sections. This fact may explain the eventual use of a combined alternating and direct-current generating system by such cities. The ease with which an alternating system may take on surrounding towns through step-up transformers should not be lost sight of and constitutes a great advantage.

From the above it appears that there is little justification for an extensive use of the 500-volt three-wire system in this country.

The larger three-wire systems are almost without exception served by shunt-wound generators. An increase of the generating capacity of such a plant is easily accomplished by adding units having the voltage of the outers. The smaller plants are using compound-wound generators, three-wire generators and sometimes balancer sets. The combination of compound-wound generators of different voltages on a three-wire system, for example, 125 and 250 volts or 220 and 440 volts, requires special attention to the switching, equalizing and indicating arrangements in order to secure proper parallel operation.

Figs. 1 and 2 show desirable arrangements.

The equalizer switches, ammeter shunts and circuit-breakers are placed on panels near the generators. The circuit-breakers

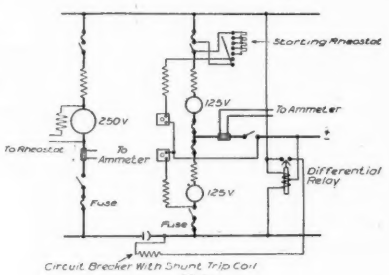


FIG. 5.

are closed and tripped electrically from the main switchboard. The low-voltage machines have their series windings on the side opposite to that connected to the neutral wire, *i. e.*, half of them are equalized on the positive side and half on the negative side. The high-voltage machines are provided with two series windings in order to admit of proper equalizing with the low-voltage machines. In the case of machines with compensators and collector rings for derived neutral, *i. e.*, three-wire generators, two series windings are necessary in order to secure with unbalanced loads a compounding approximating that with balanced loads.

It is desirable on lighting systems supplied by both low-voltage machines and three-wire machines, to provide switches in the connections between the neutrals of the compensators and the neutral bus-bar. With these switches open it is possible through the low-voltage machines to raise the voltage of one side of the system above that of the other to compensate for unequal line drop due to unbalanced load.

The proper sequence of operation of switches and circuit-breakers when connecting a machine to the bus-bars is as follows: First, close the equalizing switches. Second, go to the main switchboard and close the main switches. Third, having obtained the proper voltage relations, close the circuit-breakers by means of the controlling switches on the main switchboard. The inverse sequence should be followed when disconnecting a machine from the bus-bars.

Three-wire generators when operating separately, or in conjunction with others of the same class, or with compound machines of the same voltage but without collector rings and compensator, may be connected as shown in Fig. 1.

Low-voltage compound-wound machines connected on the two-generator method should always be connected as shown in Fig. 2, whether or not other generators are connected across the outside wires.

The advisability of the indicated arrangement of series windings where both high and low-voltage machines are installed, has been explained above. It is desirable to use the same arrangement when installing only low-voltage machines, in order that high-voltage machines may be installed later without extensive changes in existing panels. With the series fields arranged as shown, the circuit-breakers should be placed as in the diagram, in order to minimize the chances of a short-circuit in the station wiring causing a machine to operate as a short-circuited series generator.

A great saving in cost of cables for the moderate and larger size generators results from the placing of circuit-breakers and equalizing switches near the generators, and for the sake of uniformity

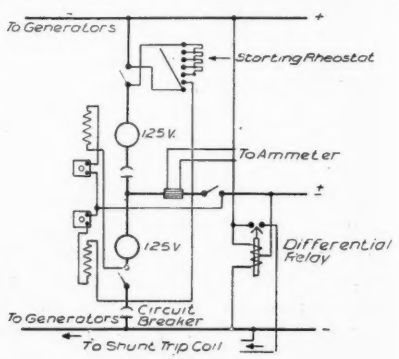


FIG. 6.

this arrangement may well be adopted for the smaller generators also.

A balancer set is sometimes depended upon to provide a neutral for a system having only high-voltage generators. The simplest way to start such a set is to connect the two armatures in series through a starting rheostat across the main buses.

It is necessary when starting to disconnect the common connection of the fields from the common connection of the armatures. Otherwise, when starting up, the field of the machine having its armature connected to the starting rheostat will receive the full potential of the system, due to the other machine having its field short-circuited by its armature. If another balancer set or other means of obtaining a neutral is in use, it is essential that the common connection of the armatures be disconnected from the neutral bus when starting; otherwise, one side of the system will be short-circuited by one of the machines.

It is advisable that the shunt fields shall in normal operation be connected between the neutral bus and the main buses, in order to secure independent control of the voltages of both sides of the system. This may be obtained by means of one rheostat common to the two fields and in series therewith, having the switch blade of the rheostat connected to the neutral bus. (See Fig. 3.) This type of rheostat is objectionable due to the extreme difficulty in predetermining its design. Two independent rheostats should be used and may be the standard for the machines composing the balancer set.

A system depending upon a balancer set for its neutral, must be protected against the consequence of a short-circuit on one side of the system, causing the full potential of the main buses to be impressed upon the other side of the system, with destructive results to the lamps and other devices connected thereto. This may result from the automatic disconnection of the balancer set due to short-circuit, or if the set is not provided with automatic circuit-opening devices, from the flashing over of the commutator of the machine on the short-circuited side. Protection may be afforded by a differentially wound relay with coils connected across the two sides of the system and contacts normally closed. These contacts close a circuit through shunt trip coils on the circuit-breakers of the main generators. This relay will operate and trip the circuit-breakers in the event of an abnormal rise of potential on either side of the system. A system having the generators protected by fuses should include an electrically tripped switch so placed in the main buses as to separate the balancer set and distributing system from the generators. The differential relay should be connected to trip this switch in event of a short-circuit or abnormal rise of potential on either side of the system.

The series fields of balancer sets may be placed on the positive side of both machines and equalized with other balancer sets in the usual manner.

Fig. 4 indicates the proper connections of a compound-wound balancer set and compound-wound generators; both being protected by circuit-breakers. Fig. 5 indicates the proper connections of similar machines protected by fuses and with an electrically tripped switch in the main bus.

The fields of shunt-wound balancer should be connected as shown in Fig. 6. It is to be noted that each machine has its field connected across one side of the system and its armature to the other. This tends to maintain balanced potentials on the two sides of the system with unbalanced loads.

The New York Electrical Society.

The New York Electrical Society, on the evening of Monday, October 19, was addressed by Professor W. E. Ayrton, of the Central Technical College, London, on "An Informal Talk on Some Electrical Measuring Instruments and Recent Use of Them." Professor Ayrton is a member of the British educational commission which is visiting the United States, and although very busy, consented to give the society the above talk, dealing with various electrical instruments, the operation of which electricians in this country are not yet very familiar with. Many of the results which can be obtained from these instruments are of great delicacy and effectiveness, and the lecturer gave to the society many of the details which are not yet on record. Professor Ayrton made copious readings from a work entitled "The Electric Arc," of which his distinguished wife, Mrs. Hertha Ayrton, is the authoress. This is the first time that the society has ever been addressed by a fellow of the Royal Society, and, on closing his talk, Professor Ayrton was greeted with prolonged applause. A discussion followed, in which Louis B. Marks, Professor Pupin and others took part.

Before the lecture there was a short business meeting. The temporary appointment by the president of Mr. E. H. Mullin to take the place as vice-president of Mr. H. C. Townsend, recently resigned, which had been approved by the executive committee, was ratified by the society.

The following members were elected: William Thomas Taylor, Schenectady, N. Y.; George W. Travis, Brooklyn, N. Y.; Sydney Hogerton, New York city; Adolph G. Keonig, New York city; Edgar H. Berry, New Brighton, N. Y.; Howard S. Rich, New York city; Dr. John Woodman, New York city.

The committees appointed for the season are:

Finance—H. D. Betts, chairman, W. S. Barstow.

Examining—W. I. Donshea, chairman, Douglas Burnett.

Reception—F. C. Bates, chairman, E. H. Mullin, H. A. Sinclair, G. H. Guy.

Membership—J. R. Strong, chairman, Albert F. Gans, Putnam A. Bates, Joseph Bijur, Louis B. Marks, Frederick A. Scheffler.

Papers and meetings—G. H. Guy.

Independent Telephone Association of Southern Indiana.

The fourth annual convention of the Independent Telephone Association of Southern Indiana will be held at Evansville, Ind., Tuesday and Wednesday, November 10 and 11. The opening session will be held at two o'clock Tuesday afternoon. The programme will consist of papers and addresses promoting the best interests of independent telephony, and special entertainment will be provided for the visitors.

The officers of the Independent Telephone Association of Southern Indiana are G. A. Kienle, president, Huntingburgh; C. D. Knoefel, vice-president, New Albany; E. W. Pickhardt, secretary, Huntingburgh; T. M. Thom, treasurer, Lamar.

Cassier's Magazine for November.

Cassier's Magazine for November will contain a number of articles on engineering topics of more than ordinary interest. One of these articles is by Mr. John Goodman, on "Superheated Steam for Steam Engines." An article by Reginald P. Bolton, on "The Apartment Hotel in New York," delineates some of the engineering problems of this subject and their solutions. "Electric Searchlights, Their Use Afloat and Ashore;" "Locomotive Building in Germany;" "The Microscope in Engineering;" "Fuel Losses in Steam Plants and How to Determine Them;" "Oil-Fired Furnaces," and a number of current topics will also be included.

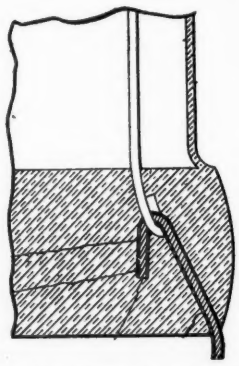
Chicago Telephone Company Opens New Branch Exchange.

The Chicago Telephone Company opened its new Douglas exchange 170 East Thirty-fifth street, Chicago, Ill., during the week of October 12. Beginning Monday, October 12, and ending Saturday, October 17, the company opened the exchange to the public and issued invitations for the purpose of inspecting the apparatus and viewing its operation. Mr. A. D. Hawk is the manager of the southern division of the Chicago Telephone Company.

Electrical Patents.

An English electrical engineer, Mr. Job T. Niblett, of Greenwich, London, England, has patented in this country a new storage battery. This invention relates chiefly to secondary or storage batteries, and has reference more particularly to the employment in such batteries of the material known as "kieselguhr" or "infusorial" earth, the highly absorbent nature of which, as well as its power of resisting the action of acids, is well known. The invention is designed to improve both the active material or coating of the plates and also the porous or absorbent separators, blocks or plates which are commonly interposed between the electrodes. This is accomplished by incorporating with such active materials and also with the materials from which the said separators or blocks are made a certain proportion of infusorial earth, whereby great porosity, both in the active material and the separators, is attained, and hence the improved cells are capable of very high rates of charge and discharge, while they can, if desired, be made practically into what are known as "dry" or "afluidic" cells. In applying the invention to primary batteries a plate of the aforesaid active material mixed with kieselguhr can be used in conjunction with a plate or plates of zinc or other suitable metal. In carrying out the invention the electrodes, which need not have the usual grid or support, are formed of lead oxides or other compounds and of kieselguhr, which are suitably compressed or moulded so that they form coherent plates analogous to the well-known lithanode plates. The active material in the above may consist of ordinary lead oxides mixed with electrolyzed lead or lead compounds which have been electrolytically prepared, or which have been so prepared that they are analogous to electrolytic compounds. Owing to this, the physical changes in the plate while in use are less likely to occur, and the active material is also rendered conductive by the presence of the electrolytic materials. The active material thus mixed with kieselguhr possesses a great degree of permeability as distinguished from the actual porosity found in some types of plate at present constructed. In other words, while the active material made up according to the invention is to the eye apparently homogeneous and compact, yet it is in its nature permeable to a high degree by the electrolyte and in no way dense and resistant to solution. The result is due to the presence of the kieselguhr, of which all the fibres or particles act as minute ducts to convey the electrolyte thoroughly into the body of the material by capillary attraction. It is superior to what is ordinarily known as "porosity," which is due simply to small holes in the material, because these holes soon get closed up by sulphate or by the swelling of the active materials. Owing to its being permeable in this way, the material can be formed in very much less time than is usually required, and the capacity of the cells made with plates of the same is very great, since practically the whole mass of the material is in action at the same time and not simply the outer layer or face of the plate. The proportion of kieselguhr may, for example, be one to five per cent for the positive pole-plate and two and one-half for the negative pole-plate; but this may be varied, and is greater the thicker the plates or blocks are required to be. The electrolyzed portion of the active material may be previously prepared from a plastic mass consisting of lead oxides or compounds made into a paste with sulphuric acid. This mass is placed in lead trays or the like and subjected to electrolytic treatment analogous to that of "forming." It is then discharged slowly in any convenient way, which causes it to assume a crystalline form very advantageous for use in the subsequent stages. The mass is then dried and pulverized and mixed with the untreated lead oxides or compounds—say, in the proportion of one to two—and the necessary proportion of kieselguhr is added at the same time, the whole being made into a paste with sulphur of ammonia, sulphuric acid, or other medium which will tend to form insoluble or partly insoluble compounds and so promote the setting. The mass is then filled into the grip or support or is moulded under pressure or otherwise to the desired shape in cases where it is to be used in the form of plates or slabs only. The inventor has found in some cases that the active material gives very good results if only the ordinary lead compounds are used—that is to say, the electrolyzed portions of the mixture may be omitted, if desired. This greatly simplifies the manufacture, while the porosity imparted by the kieselguhr is sufficient to accommodate any swelling or physical change that may occur among the molecules of the active material during the charging and discharging of the cell. For instance very satisfactory plates may be made up of about equal parts of litharge and red lead mixed with two and one-half per cent of kieselguhr and then moulded to the desired shape. The above description relates to the mode of manufacturing the plates or electrodes of the improved cells. The manufacture of the improved porous absorbent separating plate previously referred to is as follows: This is formed wholly or principally of kieselguhr, wetted, for instance, with sodium silicate and formed by moulding or compression into thin sheets or slabs, which are burned to render them hard or firm without impairing their porosity. In some cases it may be mixed into a paste with china-clay and water instead of sodium silicate and be then moulded and burned. To further increase the porosity, if desirable, powdered charcoal, coke or coal may be incorporated with the mass. These materials will be burned out during the kilning and leave behind corresponding cavities in the plate. The product may be used as a separator for the electrode in the ordinary way or may be interposed between them to serve as a medium for holding the electrolyte when it is desired to make the battery up as a block or pile in the most compact form after the manner of so-called "dry" batteries.

Improvements in connection with lead-in wires of incandescent electric lamps have been devised by Messrs. John C. Entroken and William S. Everett, of Malvern, Pa., who have assigned a one-fourth interest in the patent obtained thereon to Mr. Sheldon M. Custer, of Wayne, Pa.



METHOD OF ATTACHING LEADING-IN WIRES IN INCANDESCENT LAMPS.

The object of the invention is to provide an efficient and economical means of attaching a platinum or other coated lead-in wire to the stem of such a lamp, so designed as to effectually prevent any leakage of air into the bulb after the vacuum has been established. Attempts have been made to utilize platinum-coated lead-in wires in incandescent electric lamps because of the material reduction in cost which would result from the use of a platinum-coated wire instead of the solid platinum wire now universally em-

ployed; but such attempts have proved failures by reason of the fact that it has not been possible prior to this invention to prevent leakage of air from the stem by the embedded lead-in wires into the bulb, thereby destroying the vacuum. It

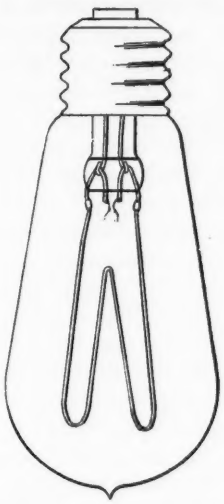
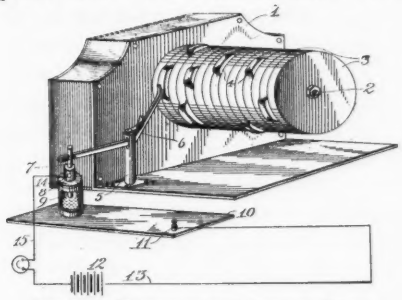


FIG. 1.—METHOD OF ATTACHING LEADING-IN WIRES IN INCANDESCENT LAMPS.

has been commonly supposed that this leakage occurred between the outer surface of the coated wire and the mass of glass of the stem in which the said wire has been embedded; but the inventors have discovered that this leakage occurred between the metallic core and the platinum coating. By their invention, they are able to prevent the said leakage, and thereby to successfully apply a coated lead-in wire to electric lamps. The improvement consists, broadly, in the employment, in connection with an electric lamp, of a coated lead-in wire having the end otherwise exposed to the air or to which air had access sealed against such access of air between the coating and the core of the wire and, further, in such a coated lead-in wire having such end glass sealed against access of air, and, further, in such a coated lead-in wire having such end bent and embedded in the glass of the stem, whereby it is sealed against access of air and furnishes a ready means of connection with the conducting wire.

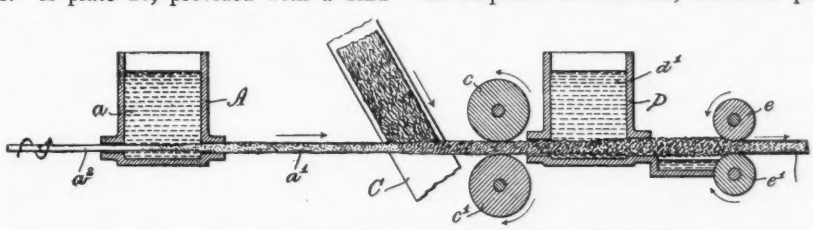
The accompanying illustration is a perspective view of a novel contact maker for electrical signs, patented by Mr. Conrad F. Lancaster, of East Liverpool, Ohio. The numeral 1 indicates the casing for the clockwork, which it is not deemed necessary to show, as any ordinary form may be used. From the casing projects a stem 2, having its outer end threaded and provided with a nut, while a shoulder is formed near the case 1. This stem is attached to a clockwork and revolves when the same is set in motion. Discs 3, having cam portions 4 formed thereon, are held on the stem 2 between the aforesaid shoulder and nut, the latter being screwed up tightly when it is desired to prevent their movement on the stem. Opposite each one of the cam-discs is set a



CONTACT-MAKER FOR ELECTRIC SIGNS.

post 5. Each post carries a spring-pressed lever 6, one end of which is in contact with its cam-disc. The opposite end of the lever carries a plunger 7, which passes through an insulating bushing 8 into the cup 9; the latter being partly filled with mercury, as shown. It is obvious that the motion of the cam-disc will move the lever and cause the plunger to rise and fall in the cup. Both cup and plunger are made of some good electrical conductor. A plate 10, provided with a binding-post 11, is connected with a battery 12 by means of a wire 13. The insulated bushing 8 has a binding-post 14 mounted thereon, the end of the post contacting with the plunger. A wire 15 leads from the binding post 14 to the battery 12. One of these wires passes through whatever lights it is desired to effect by means of the especial cam selected. It now becomes plain that when the clockwork is in motion the cam-discs are rotated and the electric circuit is completed by the plunger dipping into the mercury. It is obvious that the circuit will remain closed so long as the lever is in contact with the cam portion of the discs. The length of these portions can thus be arranged to suit any desired exposure of light. It will also be plain that the discs can be arranged upon the stem in any desired manner and such changes in that arrangement can be made as from time to time may seem advisable, without it being necessary to disturb the wiring.

John A. Heany, of Philadelphia, Pa., has patented a new method of producing insulated electric conductors and has assigned the patent to the Teter-Heany Developing Company, of Charleston, W. Va., and Philadelphia, Pa. Referring to the illustration, the metallic conductor or wire is immersed by being drawn, preferably through a bath in a vat or tank A of an adhesive substance, in order that the surface or wire may be coated with a layer or coating a^1 of such adhesive material. After the surface or wire has received its coating or layer a^1, asbestos in a fibrous form is twisted or coiled in its flocculent condition on to the rotated traveling coated wire a^2, as indicated by the arrow, in order that the minute particles or fibres of the flocculous material will thoroughly intermesh with the adhesive substance a^1 of the conductor or wire, to such an extent as that under required compression by means of compression devices c and c^1 the same will be intimately compacted on to the conductor a^2 to uniformly insulate the conductor throughout. The asbestos in its flaky or fibrous condition is supplied from a traveling-belt c, and in its travel it is taken up by the sticky covering or coating of the rotating conductor a^2. The conductor a^2 is then preferably fed through a bath of a non-destructible fire and water-proof cement or paste d^1 in a vat or tank D, which consists of a clay, as kaolin, six parts, by weight, or a lime product, as the proportion of four parts, by weight. or a metallic oxide, as alumina, two parts, by weight, or an alumina product, as sulphate of alumina, one-half part,



METHOD OF PRODUCING INSULATED ELECTRIC CONDUCTORS.

by weight, or an acid product, as borasic acid, one sixteenth part, by weight. This composition is thoroughly mixed and then one part, by weight, mixed or combined with a gluey adhesive substance in the proportion of four parts, by weight. The above proportions of the different ingredients in parts by weight may be varied and still good results be obtained. This may be the commercial glues or a mixture of glues or adhering substances heated with water or made to form a solution of the required consistency. Some of the common or commercial glues, mixed with fish-glue, as practice has demonstrated, give excellent results. The coated, covered and fire and water-proofed conductor a^2 is then passed between preferably a pair of squeeze-rolls c and c^1 for removing any surplus of the final coating of cement or paste to the conductor a^2, and then the thus-treated conductor a^2 is permitted to dry. When thoroughly dry the flocculent asbestos will be found to be embedded and surrounded with the coating and cement or paste and also united to the conductor and with the latter in such a condition as not to be affected by heat, also fire and water-proof, thereby specially adapting such a covered wire for use as a conductor for electric purposes.

American Institute of Electrical Engineers.

Two Railroad Papers Read and Discussed.

THE 180th meeting of the American Institute of Electrical Engineers was held in Carnegie Hall, New York city, Friday evening, October 23, 1903.

President Arnold called the meeting to order at 8.30 o'clock.

Secretary Pope announced that the use of the Chapter Rooms of Carnegie Hall had been secured for the meeting and possibly arrangements would be made for its continued use, but that the meeting hall of the Chemists' Club was also being considered, and it might be secured.

He also announced that at the meeting of the board of directors in the afternoon thirty-four associates were elected, and the following associates were transferred to full membership: William Howard Cole, Singapore, British India; William Atwood Hall, Lynn, Mass.; William Weedon Cole, Elmira, N. Y., and Walter I. Slichter, Schenectady, N. Y.

President Arnold introduced Dr. Cary T. Hutchinson who gave an abstract of a paper entitled "The Conditions Governing the Rise of Temperature of Electric Railway Motors in Service."

Dr. Hutchinson, in introducing his paper, said that it was practically a continuation of one he prepared a year or more ago, comparing in a general way the motor capacity and energy consumption required to make various speeds at different distances. In the previous paper, however, he assumed roughly that an ordinary tramway motor would stand an average loss of three per cent; that was an approximation, and done to carry the thing to a common conclusion. If any other value could be substituted for three per cent, the same processes could be carried through. He had carried the methods through in a different way in this paper. These had been applied to motors for any I^2R losses or core losses, and he had taken into account the results shown in service tests, tests in which the motor ran backward and forward, the being temperature measured.

Dr. Hutchinson said what he was getting at was the method of determining the different variables entering into the question of motor capacity and energy consumption, to discover a method which seems to lend itself to determining the division applicable to a motor of any radiation, and any amount of motor acceleration; to determine the different points as definitely as possible. It had been necessary to make a number of approximations and he pointed out in his oral statement which were approximations and how closely they came to the figures in the paper. He believes that curve sheets, plotted for the different motors, showing the half dozen motors made by each of the manufacturing companies, would serve a very useful purpose if disseminated, in giving information.

President Arnold said that some had found, in practice, when they had had a serious problem confronting them, that some of Dr. Hutchinson's original conclusions were nearer correct than they were assumed to be at the time the first paper was delivered. He was therefore glad that Dr. Hutchinson had presented the matter again, expanding upon it, and carrying it further so that one could ascertain something about the heating capacity of motors in selecting them for railway work. This is becoming a matter of greater importance every day, as the size of railway motors increases. He called upon Mr. A. H. Armstrong, of Schenectady, to open the discussion.

Mr. Armstrong said there were one or two things in connection with the paper that he thought worthy of very careful note. One of them was that the author had followed through a method of determining velocities in the motor, had carefully followed them out through a performance of the motor in practice, segregating the losses, dividing the armature and field losses and giving their ratio, and subsequently comparing these losses to the actual performance of the motor by means of experimental tests.

This was a subject that had received a good deal of attention on the part of various companies manufacturing motors and was really the fundamental theory upon which to get the capacity of a railway motor. The service is more or less complex and consists of frequent startings, coasting and stoppings, and not only is the work intermittent, but the speeds are variable, conditions of ventilation are variable, and at first sight the proposition seems complicated, indeed. The paper had not spent so much time on detail as it has in attempting to bring out in broad scope the service capacity of railway motors. He noticed one or two points which had not been touched on, perhaps not being necessary in the rather broad manner in which the subject had been taken up. One of them was the fact that the inertia of the rotative parts had been neglected. This might amount to much on slow-speed work, such as thirty miles an hour, but in rapid transit problems it would amount to considerable, reaching perhaps a factor of twelve or fifteen per cent, on such rapid transit problems as the New York elevated road. On suburban runs, reaching sixty miles, the acceleration of the small parts of the total energy consumed may not reach more than three or five per cent, due to the fact that the cars are operated for long distances at constant speed. Leaving out this factor was not a serious matter, in any sense. He noticed, however, that the paper was based upon the fact of a constant friction rate, and the author assumed 13.6 pounds per ton. Assuming the same friction for all speeds, and the problem is only worked out at one friction rate, the conclusions arrived at, therefore, in the final curves can not be in any way assumed as general in their application, due to the fact that train friction, especially car friction, varies with the speed. In fact, a friction rate of 13.6 pounds to the ton would not have universal application outside of rapid transit problems involving the use of four or five cars in a train and operating at speeds not above thirty miles an hour. If the problem is to be treated in a broad way it is necessary to assume a number of friction rates, according to the load, composition of train, number of cars in train, different shape of cars, etc., and not only plot the motor capacities for a single friction curve, a curve varying at different speeds, but different friction curves, each having different values at the same speed. That had not been done and led to complicated results in some of the conclusions in the paper. For instance, the paper was based upon maximum speeds reaching twenty-five, fifty and seventy-five per cent above the speed at which static resistances are cut out. With an allowance of 13.6 pounds per ton, it is possible to get these different maximum speeds, and from tests which the General Electric Company has made, and which have been corroborated by other authorities, it has been found the friction for single cars of light construction sometimes reaches a factor of fifty or sixty pounds per ton at a speed of sixty miles or more. It is obvious,

therefore, that any general conclusion based on friction rate of 13.6 pounds per ton must fall through when single cars are operated at high speeds. One of the examples given contemplates a maximum speed of fifty miles an hour, so that the author had in mind, evidently, a universal application of his curves.

Mr. Armstrong quoted some figures on the maximum speed which it is possible to reach with different friction curves. For instance, single cars operated alone at a maximum speed of thirty miles per hour, with a motor of modern construction, having ordinary speed torque curve, makes it possible to reach a speed double that at which static resistances are cut out; in other words, expressed in the terms of the author's paper, a factor of 200; for two cars, operated at the same speed if possible, 226; while for a train of heavy cars, using the curves which are given here for such work, a factor of 250 is obtained. The curves in the paper of 125, 150 and 175 would hold for this class of work. For higher friction rates, however, that is for single-car operation at speeds of fifty, sixty or seventy miles, possibly seventy-five miles per hour, this factor is not possible. For single-car operation it is hardly possible to get above the factor of 123; for two cars 140; for a train of heavy cars, giving the lowest friction rate, we possibly could reach 190. If the conclusions were based on a factor of 150, and the paper carried the factor through, it would be hard to apply the results to universal railway work, especially in high-speed problems. He looked upon the results of Dr. Hutchinson as being applicable more especially to suburban work or slow maximum speed work, similar to the rapid transit problem on the New York elevated railroad; but they would hardly touch the underground rapid transit system on account of the high speeds adopted.

Dr. Hutchinson gave a table in his paper showing the motor capacities for certain runs. Mr. Armstrong gave some figures evolved by some practical tests of motors as to the energy consumed, which actually gave, as far as energy consumed and relative motor capacity are concerned, some results in good agreement with those in the paper. Moreover, figures obtained for relative motor capacity were still more remarkable as checking very closely indeed with the paper.

However, he did not find the same uniformity of agreement in the figures for the horse-power performance based on one-hour rating with seventy-five degrees rise. He would, under similar conditions, recommend a motor of half the capacity recommended by the author, still feeling sure that temperatures of seventy-five degrees could not be exceeded.

It had been found that at speeds approaching sixty miles an hour it is possible that the motor capacity will vary after some temperature rise as much as twenty per cent, depending upon the composition of the train, whether a single car is operated alone or whether a single car is operated in a train consisting of five or six cars or more. It is necessary to treat the high-speed suburban problem upon the basis of a friction curve plotting a number of them, to meet the different conditions, and finding the motor capacity that best applies to the condition at hand. The energy consumption also obviously becomes a factor of the initial friction assumed, especially for very high speeds, sixty miles or more. In slow speeds and in the paper read by the author where a small friction rate is assumed and the acceleration of the train demands a greater amount of energy, the friction is of secondary importance and does not affect greatly either the motor capacity or energy consumed. At higher maximum speeds, approaching sixty miles per hour, it is especially for single-car work where the friction is known to be high, it is necessary very carefully to figure this and it will be found that the energy consumption depends directly upon it. For a single car of twenty-five tons, operating fifty miles an hour, the friction rate may run as high as fifty. So that it is necessary to consider the friction rate and elaborate it or complete it for other friction rates than that given by the author for the high speeds.

Dr. Hutchinson in reply said that Mr. Armstrong had tried to apply a method to certain cases which was not intended to be applicable. His own paper applied to one friction rate, and if it was desired to apply it to another friction rate, more curves must be made. There were one or two points in connection with Mr. Armstrong's remarks which he hardly felt able to discuss without knowing more definitely how Mr. Armstrong got at them. Regarding the question of motor capacity, and the figures presented by Mr. Armstrong, the trouble is that his own figures call for a run of 7,000 feet and those of Mr. Armstrong for one mile only. Thev check pretty closely and correctly, if that difference is born in mind.

Simple curves can be worked out for each particular friction rate desired. The various maximum velocities of 125, 150 and 175 were merely taken for the purpose of comparison.

President Arnold called upon Mr. A. H. Armstrong to present his paper entitled "A Graphic Recording Ammeter." He said that he was really reading another man's paper, that Mr. Robinson, of the research department of the General Electric Company, has designed the instrument.

In connection with the previous paper, there had been various curves plotted on the blackboard and the paper itself showed the necessity of a recording instrument capable of reading violent fluctuations in current accurately on a car that is moving and jarring the instrument, starting and stopping, thus subjecting it to strains and inaccuracies which we did not expect previous instruments to live under. Previous to the inventing of an instrument that would do this work, it has been the universal custom to appoint a number of observers to take readings of various lengths of time, two seconds is about as quick a time in which a man could take a reading, one reading and another man taking down the results, all the men working at the stroke of the gong, the whole process being tedious and open to criticism of being more or less inaccurate. With the introduction of heavier railroad work, where the motors aggregated several hundred horse-power, where temperatures had to be reliable, where the actual duty of a motor could be plotted beforehand with a great degree of accuracy, the need of such an instrument was felt; an instrument that would enable us to make preliminary tests and record the readings with a considerable degree of accuracy.

This instrument was brought out by the General Electric Company, not so much to put it commercially on the market or for general application, as it was to enable them to better study and let others have the benefit of that study of the subject of railway motors in operation. The instrument itself consists of two coils carrying line current or a part of the line current. Inside is a secondary coil energized from a separate source and a storage battery. There is an ammeter to keep this current at the required strength and to calibrate the instrument by using different strengths of current. The power used in the instrument is considerable, and owing to the fact that it is used on railway work but several hundred kilowatts are involved; it may use several hundred watts in its operation, as such a quantity would not be noticed in the total power equipment of the train.

The instrument has a "dead-beat" attachment, and is very nearly "dead-beat." It reaches its maximum reading instantly, does not go beyond, and comes immediately to zero. The instrument and samples of its work were exhibited.

The meeting then adjourned.

Reviews of Current Engineering and Scientific Literature.

Statistics of Electric Railways in France.

A set of quite complete statistics of the railways of France is here published, all classes of roads being considered. A summary of the data for the electric railways up to January 1, 1903, is as follows: The total length of the lines is 1,994.7 kilometres. The total power is 73,997 kilowatts. On these roads there are operated 3,004 motor cars. There are eighty-five lines using the overhead trolley only, there are three using the underground conductor only, five with the third rail and eight with accumulators. There are thirteen lines using both accumulators and trolley, but there are four with a mixed trolley and conduit system, thirty-one with a mixed surface contact and trolley, and three using a trolley on ordinary roads. Ten years ago there were but 37.4 kilometres of electric railway in France with a total power of 1,525 kilowatts operating with twenty cars. There were two trolley lines, one third rail and two accumulator systems.—*Translated and abstracted from L'Industrie Electrique (Paris), September* 25, 1903.

Railway Cross-Ties.

Much ingenuity has been expended during the past twenty-five years in a search for a substitute for wooden cross-ties. Steel and concrete have been tried, but so far without entire satisfaction, at least in this country. The need for some substitute is becoming more imperative every year, because, although there has been a great increase in demand, there has been no corresponding increase in the supply of first-class ties. The railroads have been forced to make use of inferior timber and all kinds which formerly would not have been accepted. There has, however, been an extended use of treated ties, the endeavor being to make inferior wood more valuable. It is said that the life of a white oak tie has fallen from nine years to four or five years because of poor quality as well as the harder service. California red wood is rapidly worn by sand under the rails. Beech is worthless. Red oak is good for only four years, though by chemical treatment this and other woods may be made to last from ten to fifteen years, but it is difficult to secure a thorough treatment which will last. Under such conditions it is strange that one variety of wood, a native of the United States, has not found a wider use, as this wood is practically immune to the attacks of rot fungus. This is catalpa speciosa, a rapid-growing tree. The earliest railways of southern Indiana, southern Illinois and southeast Missouri were constructed near the catalpa swamps, and whenever possible made use of this wood, and engineers on these roads now have samples of ties which were in use fifteen or twenty years ago. Many of these older ties have been removed, because they were not thick enough for the new heavy rails, but when removed few of them were found to be badly decayed. Some of these ties have been in use thirty-one years, during which time five sets of white oak have decayed and been removed, but the catalpa is sound to-day. Poles of this wood were also made use of for the telegraph lines; several hundred of which still remain in use.—*Abstracted from Arboriculture (Indianapolis), October,* 1903.

The Electrified Mersey Railway at Work.

Comparison is here made of the operation of the Mersey railroad since its conversion to electricity with that while steam was used. The entire absence of smoke, both in the stations and tunnel, is one of the most noticeable improvements. When steam was used the trains accelerated rapidly when descending the incline from the station, and mounted but slowly the rise to the other station. With the motors this change of speed is hardly noticeable, the trains running at a practically uniform speed. Trains are run throughout the day every three minutes, there being a total of 750 trains for the working day. Under the old conditions there were about 283 trains for each week day. The effect of the change in motive power and schedule was an immediate and large increase in the traffic. In the first full week of service 125,272 local passengers traveled over the railway, an increase of 37,619 over the number carried for the last week of the steam service. Compared with the corresponding week of last year, the increase was 32,875. There has been an increase in the taking of forty-five per cent on the amount taken during the last week of the steam service, and forty per cent on the amount taken in the corresponding week last year. Excluding the holiday traffic in Whitsun week, the traffic shows an increase since the electrified service began of thirty-five to forty per cent. These figures relate only to what is termed local traffic, and do not include passenger traffic with distant stations on other railways worked over the Mersey railway. It was believed by the officials of the Mersey road that, when the clearing house returns were received, a material increase would have to be made to the increase of thirty-five to forty per cent reported in the local traffic.—*Abstracted from the Tramway and Railway World (London), October* 8.

Experiments on Selective Wireless Telegraphy.

The system of selective wireless telegraphy developed by Mr. Anders Bull was described in the ELECTRICAL REVIEW for January 24, 1903. In this article the inventor gives a short account of some practical tests conducted at the invitation of the Marconi Wireless Telegraph Company. The system is yet in the experimental stage, and the tests were conducted with the sole view of ascertaining the possibility of secretly communicating between stations and the further possibility of sending messages by means of selective telegraphy to several independent receivers at the same time. The first tests were conducted between the Marconi stations at Chelmsford and Bloomfield, a distance of three and one-half kilometres. These having proved satisfactory, the receiver station was removed to Frinton-on-Sea, Chelmsford acting as the sending station. These stations are fifty-five kilometres apart, but on account of intervening hills the district is rather unfavorable to wireless telegraphy, and the equivalent at sea would be about four times as long. Atmospheric disturbances rendered the tests difficult. The sending station was equipped with a single air wire, the receiving station using a "jigger." The air wires were fifty-three metres high. It was found that the Marconi receivers, although exceedingly sensitive, could not be used, as one of the chief conditions required by this system is the quick and distinct marking of the impulses received. A special tapping device was designed and is here described. In this the relay current is interrupted by the movement of the decohering armature before the coherer has ceased to vibrate. The speed of transmission is the same as that with the ordinary Marconi apparatus, and under favorable conditions, messages were received very clearly. These results were obtained with primitive apparatus, and the inventor believes that they demonstrate that the system is applicable for all practical purposes where it is desirable to prevent outsiders from tapping messages.—*Abstracted from the Electrician (London), October* 2.

Successful Automobile Trip with an Edison Storage Battery.

A successful tour from Boston to New York was made last week in a carriage equipped with the new Edison storage battery. There were no mishaps, except a little trouble with one motor toward the end of the run and at no time was the carriage stalled, though some stiff hills were climbed. The following is a report of the trip in detail:

Left Boston October 20, at 11.30 A. M. The carriage was formerly a Columbia tonneau belonging to Mr. Charles L. Edgar, president of the Edison Electric Illuminating Company of Boston. It was driven by Mr. H. M. Wilson, of the automobile department of the Edison company. This carriage Mr. Edgar had fitted up with a new Edison storage battery, removing the tonneau and making it a single-seated carriage, and putting in sixty-eight cells, in place of the forty-four lead cells, the weight of the battery being practically the same as before. The carriage was equipped with two eighty-volt motors.

On the first charge the carriage ran through to Worcester, passing through Wellesley Hills, Southboro and Northboro, arriving at Worcester at 4.45 that afternoon. It remained at Worcester overnight, charging part of the time at an automobile garage at a low rate, and for a short time the following morning at the Worcester Electric Light Company's station at a high rate. The start from Worcester was made at 12.30 on Wednesday, October 21, and the run was made through to Springfield without any trouble whatever. The famous Leicester hill was climbed, a hill that has stalled a great many automobiles and which all automobilists dread. The battery gave out 100 amperes of current during a greater part of the time, and at the discharge reached 102 amperes. From Leicester to Spencer, on the run to Springfield, the road is very hilly, and at Brookfield it was almost impassable. In fact, for an eighth of a mile it was necessary to take to the sidewalk, passing between a line of trees and the stone wall and fences, owing to repairs that were being made to the road at that time. From Westboro to Palmer the road was also very bad. In fact, it is the most abominable piece of road in Massachusetts. Arrived at Springfield at 6.34 P. M., the cyclometer recording sixty-three and one-half miles from Worcester. On reaching Springfield the carriage could have run ten miles more, if necessary, on the same charge. It was placed on charge from 8.30 to 11 P. M., at a twenty-ampere rate.

On the following morning the carriage was on charge from 8 to 11 at forty amperes. Left Springfield at 11.15 on Thursday, and arrived at Hartford at 1.45 P. M. Was on charge at Hartford two hours at forty amperes, and continued to New Haven that afternoon, arriving there at 9.10 P. M. Most of the way between Hartford and New Haven is a good macadam road, but there are some bad sandy stretches and rough country roads, but no grades of any account. At New Haven went on charge for two hours at a low rate, owing to the poor facilities for charging there. In the morning changed over the wiring on the switchboard and put the carriage on for three hours at a higher rate, leaving New Haven at 1 o'clock. Reached Bridgeport at 3.50 P. M., charging at Bridgeport one and one-half hours at thirty amperes. Continued to Stamford through a hard rain and over heavy roads. At Stamford the carriage remained on charge overnight, leaving there on Saturday morning. From Stamford to New York, owing to the rain of the night before, the roads were very heavy, and in many places the normal conditions of the road were wretched, being sandy and rough. At Portchester a stop of two hours was made. Rear wheels were taken off and gears, brake bands and pinions thoroughly cleaned and oiled. After leaving New Rochelle it was noticed that the motors were taking more current than necessary to drive the carriage on a level, and it was found that one of the motors was heating up. Stopped thirty-five minutes to examine motor and allow it to cool, and then continued to New York, the motor drawing current considerable above the normal rate. Arrived at 1684 Broadway at 4.45 Saturday afternoon, and upon examining motor it was found that an armature band wire had broken, which accounted for the extra discharge rate required to run the carriage, and the consequent heating of the motor.

The total distance from Boston to New York, according to cyclometer, indicated 249⅛ miles, this being about five miles more than the actual distance, owing to losing the road on two occasions. The trip could have been made in much shorter time, and charging facilities been better. The various charging outfits in the different towns are equipped merely for small carriages charging at low rate, and in only Worcester and Stamford was it possible to charge the battery at the rate desired. The actual running time was twenty-four hours and fifty-six minutes, making the average speed ten miles an hour.

Preliminary Programme of the International Electrical Congress.

The International Electrical Congress will be held at St. Louis during the week beginning September 12, 1904, in connection with the Universal Exposition. This is the week preceding the session of the great scientific congress appointed by the exposition.

On the morning of September 12 a general convocation will be called. On the four succeeding days the eight sections will be held simultaneously. On the final day, September 17, a second general convocation will be called.

As at present proposed, the international congress will comprise three distinct features: First, a chamber of delegates, appointed by the various governments, which will consider matters requiring international action. Second, the main body of the congress, divided into the following sections: General theory—Section A, mathematical and experimental; applications—Section B, general applications; Section C, electrochemistry; Section D, electric power transmission; Section E, electric light and distribution; Section F, electric transportation; Section G, electric communication; Section H, electrotherapeutics. It is purposed to invite prominent men in various parts of the world to contribute special papers on the subjects represented in the various sections and their subdivisions. Third, conventions will be held simultaneously in connection with the congress, by various electrical organizations in the United States. It is the intention that each section of the congress may be able to hold its meetings under some plan of conjunction with the organization or organizations devoted to the progress of the work selected by that section. The following prominent organizations will cooperate: American Institute of Electrical Engineers, the American Electrochemical Society, the National Electric Light Association, the Association of Edison Illuminating Companies, the Pacific Coast Transmission Association and the American Electrotherapeutic Association.

The plans of the committee of organization are to invite all interested in electricity and its applications to accept membership in and to attend the congress if possible.

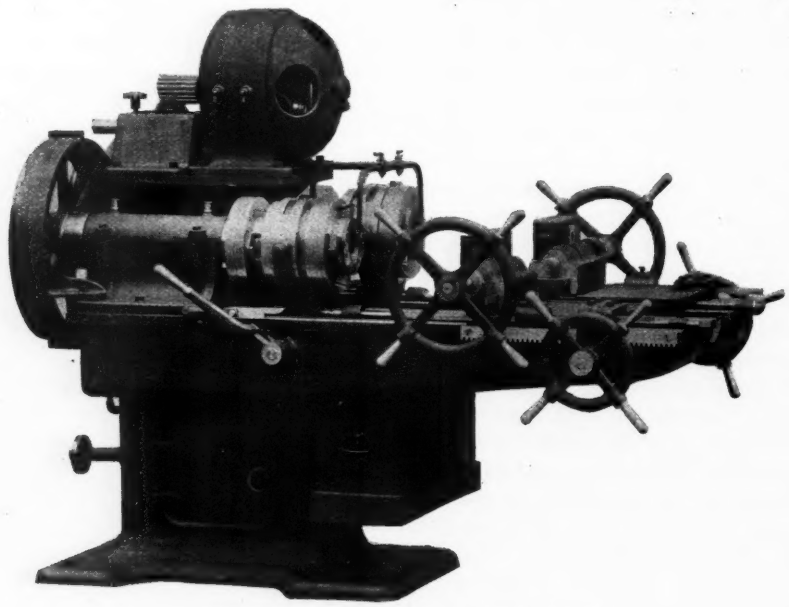
The fee for membership has been fixed at $5, and each member will receive a copy of the report, which will be published in one or more octavo volumes. Those intending to subscribe should signify their intention to Dr. A. E. Kennelly, Harvard University, Cambridge, Mass., general secretary of the committee of organization.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Motor-Driven Double-Head Bolt Cutter.

The accompanying illustration represents the standard type of double bolt cutters with motor drive as brought out by the Reliance Machine and Tool Company, Cleveland, Ohio. This machine is in all its details the same as its standard well-known machine with the exception of the belt pulley, this being replaced by the motor. This motor is placed between and above the head stocks of the machine, keeping it absolutely free from oil and chips and thereby occupying no valuable floor space. The specifications



MOTOR-DRIVEN DOUBLE-HEAD BOLT CUTTER.

for this machine, which was primarily built for one of the United States navy yards, called for an exceptionally large range of speed and novel means were devised to meet these conditions. A three-horse-power reversible, variable speed motor was used, giving a speed variation of three to eight, and by means of gears placed between the pinions on the motor shaft and the main pinion on the machine this ratio increases from one to six. By means of a speed controller, which is not shown in the illustration, in connection with the motor, eighteen spindle speeds are obtained. This arrangement, it is stated, has proven to be very satisfactory and is meeting with universal favor. While in this particular case and in many subsequent ones the Crocker-Wheeler motor and Cutler-Hammer controller were used, the manufacturer is prepared to furnish any standard electrical equipments and connect the same either by direct gearing, belt or silent chain.

A Transformer for Polyphase Circuits.

The Kuhlman Electric Company, Elkhart, Ind., has designed a new transformer for polyphase circuits, replacing the individual transformers made use of in ordinary practice in power and lighting circuits by a composite transformer having separate magnetic circuits combined as are the wires of a polyphase circuit.

This transformer, for both lighting and power loads, draws equally from the several primary phases. This feature, together with several others of importance, makes this type of transformer of great service for polyphase circuits. The advantages which the manufacturer claims for this transformer are as follows: Secondary distribution for power service which equally loads the three primary phases and maintains balanced voltages; secondary distribution with mixed lighting and power load which draws equally from the several phases; compactness of construction and improved appearance; reduced weight and less cost as compared with its equivalent capacity in single-phase units; wide range of voltage which may be obtained, and simplicity of connections.

Fig. 1 shows a front view of a polyphase transformer assembled, and Fig. 2

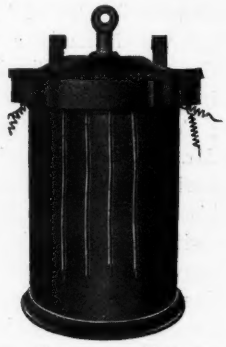


FIG. 1.—POLYPHASE TRANSFORMER.

shows the apparatus installed on the proper hanger. Fig. 3 shows the three-phase four-wire connection.

To complete the full line of polyphase transformers the company has designed a

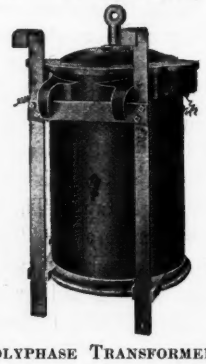


FIG. 2.—POLYPHASE TRANSFORMER ON HOOK.

two-phase composite type which is placed in the line of cases as shown in Fig. 1. In addition to its use as a two-phase transformer, it may be used on single and three-phase circuits.

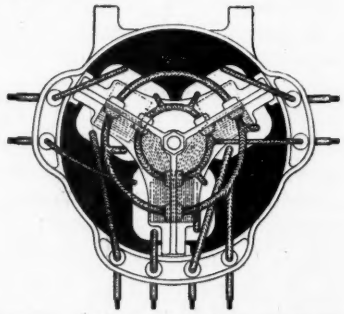


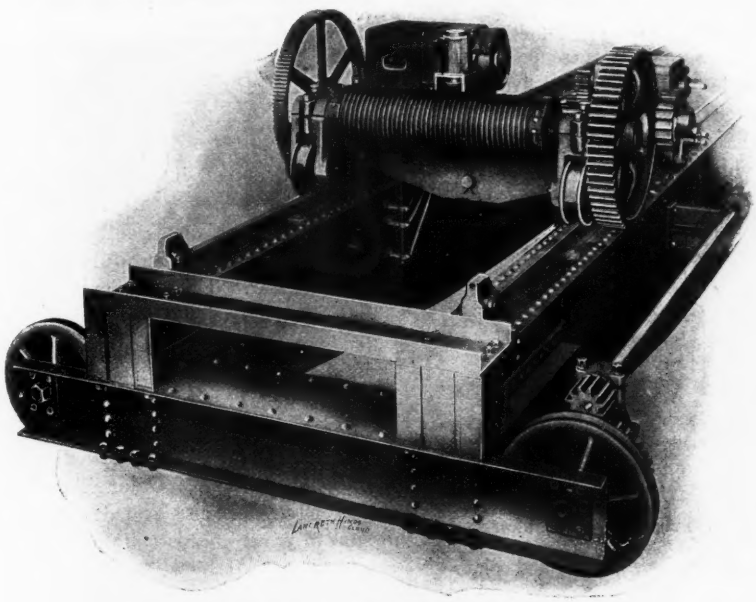
FIG. 3.—THREE-PHASE, FOUR-WIRE CONNECTION.

The case is cylindrical in form, which gives room for a comparatively large body of oil, and has a large external radiating

surface, ensuring low temperature rise under continuous full load.

The coils are wound directly on the iron, with one primary and two secondary sections on each leg, and it is stated that all the connections of a three-phase circuit which may be made with three separate transformers are possible with the construction of this transformer.

The following are some of the voltages which may be obtained from the same transformer: One thousand volts primary —100, 200, 173, 346 volts three-phase; 100 and 200 volts six-phase; 100, 200 and 346 volts three-phase four-wire. Two thousand volts primary—200, 400, 116, 232 volts three-phase; 116, 232 volts six-phase; 116, 232, 400 volts three-phase four-wire.



Crane with Trolley in Place.

Electric Traveling Cranes and Electric Hoists.

The accompanying illustrations show an electric traveling crane with trolley in place and an "Armington" electric hoist built by the Cleveland Crane and Car Company, of Wickliffe, Ohio.

The Cleveland electric cranes are designed to meet the requirements of the most severe continuous service. The design, material and workmanship are of the highest order, and all apparatus is built to fulfil the most exacting requirements.

The electric traveler, as delivered, includes the bridge with operator's platform, trolley and running block, the whole complete ready to be placed on the runway track. The electrical connections are made complete to the main feed wires along the crane runway.

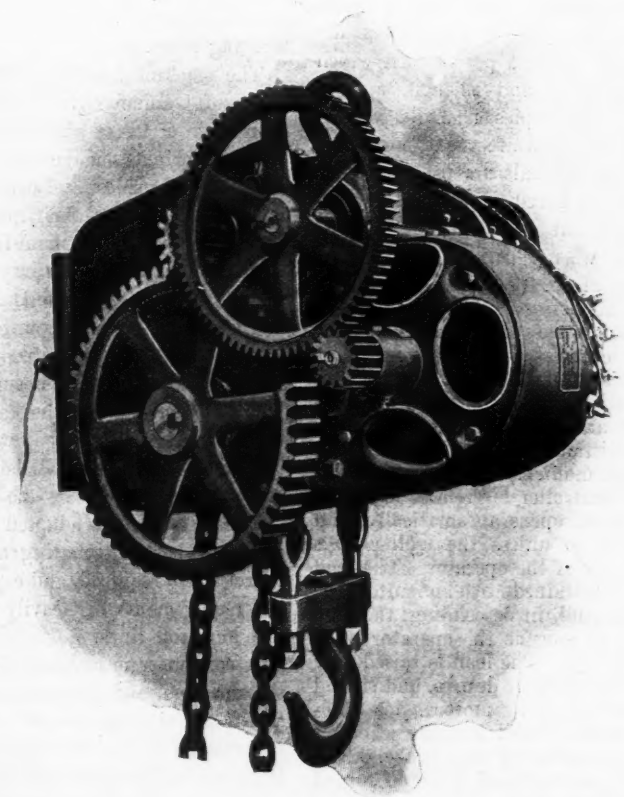
A factor of safety of at least five is used in the design of all details, and a larger factor of safety where conditions require it. The bridge may be dsigned as a single I-beam girder, single-plate and angle or double-plate and angle (box girder), depending upon the span, capacity and speed required. In case of a long span and high speed, a girder of the lattice truss type, with auxiliary bracing, may be most suitable. The bridge trucks are usually built of box section from structural steel. The girders are rigidly connected to the bridge trucks with fitted bolts and lock washers. The bridge gears have teeth cut from the solid and are of ample face to ensure a minimum amount of wear.

The cab is of ample size for all electric controlling mechanism under the care of the operator and to allow sufficient floor space for operating all the crane functions easily. A powerful foot brake to control the speed of bridge travel is furnished for use by the operator in the cab.

The trolley consists of a cast-steel or iron frame carrying all the mechanism required for hoisting and racking the load. The trolley gears are cut from the solid, and all the hoist gears are of steel. The pinions on both trolley and bridge with less than twenty teeth are cut from solid steel forgings.

The hoist drum is finished with right and left-hand grooves, keeping the load equally distributed on both girders.

The track wheels for both the bridge



Electric Hoist.

and trolley are double-flanged, cast of steel or charcoal iron with chilled tread. The tread is designed for the required runway rail and is ground true to diameter.

A mechanical safety load brake is provided with each crane. This is self-lubricating, entirely automatic, and keeps the load under control at all times. By reversing the motor the lowering is effected through this brake with regularity and safety.

The electric brake, of the solenoid type, operates on the armature shaft of the hoisting motor. This brake automatically releases when hoisting or lowering, and is immediately applied when either motion ceases.

The running block is built entirely of steel, and all sheaves are lined with bronze bushings. The hook is forged from best grade chain iron and is made to swivel freely under the heaviest load. The best grade of short-link crane chain or best pliable crucible steel hoisting rope is used with all the running blocks.

Ample provision is made for lubrication where required. All shaft journal bearings are provided with compression grease cups.

The "Armington" electric hoist shown in the accompanying engraving is designed for use where a power hoist which is easily operated and efficient, and at the same time occupies a small space, is desired. The hoists are made largely of steel, and the journals are provided with bronze bearings bored in place, giving accurate alignment for gears. No differential or worm gearing is used, the gears being all of the spur type, heavy pitch and cut from solid forgings.

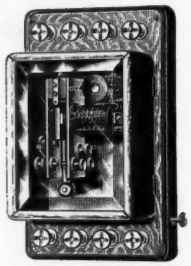
The motors are of the series-wound multipolar crane type. The controllers are of the face-plate type, and the construction makes them fireproof. The contact pieces are substantial and durable, and the resistance sufficient to regulate the speed of motor from no load to full load. The controller lever is so arranged that the circuit opens automatically, and must remain so unless the trolley rope is in the hands of the operator. The load is entirely sustained by an automatic safety brake, and, in descending, the load moves only as long as the operator pulls the pendent rope. The load is raised only as long as the operator desires, and should he suddenly leave, the motor stops automatically and the load remains where it was left suspended by the brake. The hook is well proportioned, made of forged steel, and swivels easily.

The Cleveland Crane and Car Company, in addition to the apparatus described above, makes a number of special forms of hand and electric jib post and car cranes and hand-power traveling cranes.

A New Type of Pole-Changer.

The Illinois Electric Specialty Company, 171 South Canal street, Chicago, Ill., is placing on the market the Illinois pole-changer. The accompanying illustration shows one of these pole-changers, which is but nine by six by five inches in dimensions, weighs five pounds and is adapted to all alternating circuits.

This apparatus is simple, rigid and compact in construction. Its mechanism is mounted on an oak base covered by an



NEW TYPE OF POLE-CHANGER.

oak hinged box with beveled plate-glass front. The instrument is so constructed that it will work in either a horizontal or ordinary position, admitting of its being mounted on a cabinet, hung on a wall, or in any other convenient place. In operation it is practically noiseless, and therefore not objectionable in the working room.

The machine has three contact springs made of German silver, and the contact points are of heavy sheet platinum. The contact springs engage alternately from their opposite sides, and consequently can not be forced out of their normal position by extended use. The manufacturer states that it is impossible for any of the parts to get out of adjustment, as the whole mechanism is securely mounted and locked in one solid heavy brass frame. It is also stated that the machine never requires adjusting after leaving the factory, except for regulating the speed, which is done by simply sliding a small bolt on the end of the vibrator rod.

The instrument is adapted for use where either or both alternating and pulsating currents are required, and especially meets the requirements of heavily loaded party and long toll lines.

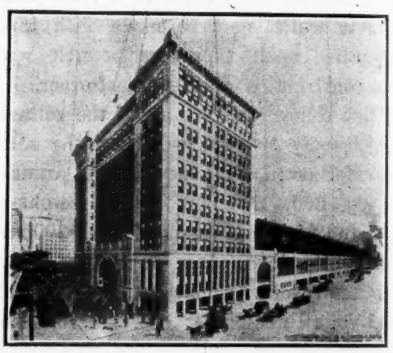
A condenser is mounted in the base of the machine, and is permanently bridged across the ringing circuit. This entirely controls on common-return systems what is known as the generator noise, and also reduces to a minimum sparking at the contact points. A resistance coil is also placed in the battery circuit to prevent any injury to the machine by an excessive flow of current in case of accidental short-circuits.

There is no consumption of main battery current, only when the operator presses the ringing key. This reduces the cost of maintenance, which consists only of battery renewals.

The New Passenger Station of the Lake Shore & Michigan Southern Railway.

The accompanying illustration shows the new passenger station of the Lake Shore & Michigan Southern Railway, which was opened on July 12 of the present year. This is known as the La Salle street station, and the building extends along Van Buren street, between La Salle and Sherman streets, Chicago. This is one of the most conveniently located passenger stations in Chicago, being in the heart of the business district and the only one on the Union Elevated loop. All of the Chicago elevated railway trains stop in front of this station and are connected with it by a covered passageway, so that trains may be taken directly from the second or main floor level without descending into the street.

The main building is thirteen stories high, with a frontage of 213 feet. It is



NEW LA SALLE STREET STATION OF LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

202 feet deep, the area being 43,026 square feet. The train shed is 213 by 575 feet, and the power-house is 220 by 145 feet. The first floor contains dining room, ticket offices and a lobby 100 feet square. The space devoted for baggage room purposes is 110 by 360 feet in size. On the second floor is the main waiting room, ladies' waiting room, gentlemen's smoking room, waiting room for elevated railway trains, and ticket offices. The total area of waiting room space on this floor is 17,322 square feet.

Alaskan Telegraphy.

The connection of Seattle and St. Michael's by telegraph is now complete. Messages are forwarded to Nome by mail.

Dispersion Lenses for Searchlight Projectors.

The Carlisle & Finch Company, Cincinnati, Ohio, has recently brought out a new design of searchlight wherein its "Dispersion" lens can be used and at any instant can be substituted by the regular lens with practically no trouble. The "Dispersion" lens, as the name implies, is a glass lens to be used in searchlights for the dispersion or spreading out of the light.

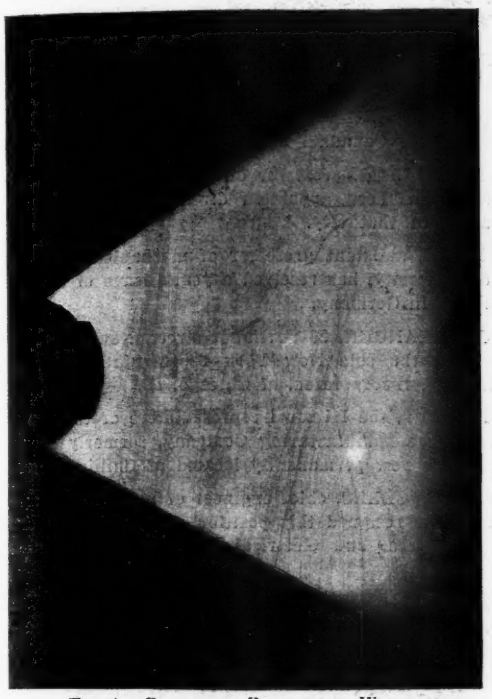


FIG. 1.—DISPERSED BEAM WITH WIDE-ANGLE LENS.

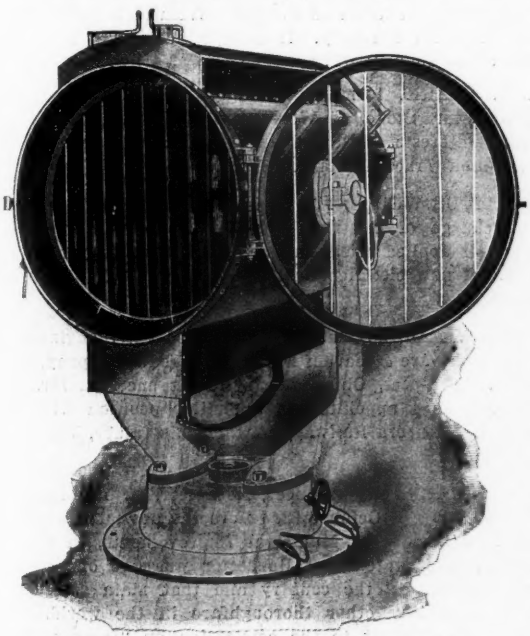


FIG. 2.—COMBINATION APPARATUS FOR CONCENTRATED BEAM AND DISPERSED LIGHT PROJECTION.

These lenses are made of strips of heavy plate-glass, one side of which is ground to a convex curve and highly polished. When the light passes through these strips it is first converged or brought together, and then as the rays cross they spread out again, and continue to spread indefinitely. The light is spread out flat or horizontally, as shown in Fig. 1, but not vertically and hence lights up objects on a flat surface much better than the ordinary straight beam. When the light is spread out as in Fig. 1, it is incapable of penetrating very far and for this reason the ordinary lens, which throws a straight beam, capable of penetrating to a considerable distance, is essential to a searchlight. The apparatus, as shown in Fig. 2 with the door swung open, which the company is now placing on the market, embodies both of these features.

The "Dispersion" lens is arranged on two semi-circular brass rings so pivoted that it can be swung around on the vertical axis as shown in illustration, and does not interfere with the light when an ordinary lens is being used. Fig. 3 shows the lamp with the "Dispersion" lens in place. On the top of each searchlight cylinder are two brass handles by means of which either lens may be swung into or out of place.

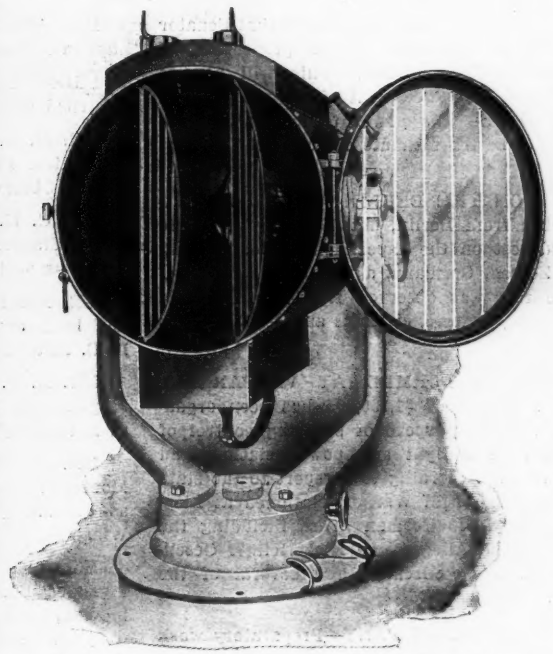


FIG. 2.—WIDE-ANGLE LENS, MANIPULATED BY BRASS HANDLES ON TOP OF PROJECTOR.

Automobile Cars for Railways.

The use of automobile cars—that is, light cars equipped with a small engine—is receiving a good deal of attention in England, in connection with lines where traffic is light. Two types of car are described in the October issue of the *Tramway and Railway World.* The first was constructed for the Southwestern and the Brighton Railway companies, and is being run between Fratton and Southsea. It has a first and a third-class section. The two may be separated by a sliding door. The total seating capacity is forty-two. The carriage body is fifty-six feet long overall and is carried on two four-wheel trucks. The motive power is steam, the engine cylinders having a stroke of ten inches and being seven inches in diameter. The rate of acceleration gives the coach a velocity of thirty miles an hour in thirty seconds.

The other type of car was designed by the Wolseley Tool and Motor Car Company, of Birmingham. The coach does not differ much from that just described, but the car is driven by motors, the power being supplied from a generator on the car which itself is driven by an oil engine. This method was adopted to secure the advantages of electrical control. The oil engine is rated at eighty horse-power. It has four cylinders and runs at 420 revolutions per minute. The generator is rated at sixty kilowatts, 500 volts, and is separately excited. A fifty-horse-power railway motor is mounted on each of the two trucks. A battery of forty cells, with a ninety-ampere discharge rate, is carried beneath the car and furnishes power for the lights and assists in starting the engine.

Gasoline Automobile Handbook.

The A. L. Dyke Automobile Supply Company, St. Louis, Mo., has published a gasoline automobile handbook, entitled "Diseases of a Gasoline Automobile and How to Cure Them." This book is written by Messrs. A. L. Dyke and G. P. Dorris, and takes up in detail the miscellaneous accidents and troubles which are experienced in the handling of gasoline automobiles, delineating the parts and their different functions, and giving ready means for getting over these difficulties.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

SHOSHONE FALLS POWER PLANT—It is stated that Senator William A. Clark, of Montana, has under way a proposition to utilize the power of Shoshone falls, Idaho. This will require an outlay of $2,000,000. An electric power plant which will generate 48,000 horse-power and distribute this power to towns within a radius of 200 miles is said to be the ultimate object of the present plans.

NEW SPEED RECORD ON THE BERLIN-ZOSSEN EXPERIMENTAL LINE—Despatches from Berlin, dated October 23, state that during another speed test on the experimental electric railroad from Marienfeld to Zossen, Germany, a rate of 131 miles an hour was achieved. The test was observed from the Dahlwitz station by a number of military officers, civilians and other persons interested.

WATER POWER COMPANY FORMED AT VALPARAISO, CHILI—A company with a capital of $1,190,000 has been organized at Valparaiso, Chili, for the purpose of securing control of water power, erecting an electric light and power station, and taking over the horse-car lines. According to a report to the state department from United States Consul Warner, stationed at Liepsic, Germany, in this company are German firms, including the Siemens-Schuckert Company, the Allegemeine Elektricitäts Gesellschaft, the Union Elektricitäts Gesellschaft, and several of the banking houses in Berlin.

MEXICAN LIGHT AND POWER COMPANY—Preparatory work has been practically completed and actual construction operations are to be begun shortly by the Mexican Light and Power Company, Limited, on the transmission line which is to be erected between the company's large power plant at Necaxa and El Oro, Mexico. The length of the line will be about 100 miles. The company has let contracts for various equipments for the Necaxa plant, which is to have an initial capacity of 45,000 horse-power. The turbines will be built by Escher, Wyss & Company, of Zurich, Switzerland. A transmission line will also be built from Necaxa to Mexico City, a distance of ninety miles. It is stated that about 50,000 horse-power will be required for the purpose of operating all the mines in and around El Oro and for working various railway lines under construction. The Necaxa plant will be increased in capacity up to 80,000 horse-power. Mr. Hugh L. Cooper is engineer in charge of the construction of the Mexican company's system, and is now in Mexico, and Mr. F. S. Pearson is vice-president and chief electrical expert.

FATAL ACCIDENT IN THE NEW YORK RAPID TRANSIT SUBWAY—Following a slight blast in one of the tunnel excavations on the route of the rapid transit subway in New York city there was a cave-in which resulted fatally to a number of workmen. The loosening of a boulder in the rock formation above the roof of the tunnel resulted in the collapse of about 100 feet at 195th street on Saturday evening, October 24. Of the persons caught in the accident, six were killed instantly, three lingering for some time pinioned down by heavy masses of rock. Another man who was released from the débris and conveyed to the hospital died shortly after reaching there. All of the dead men, except Timothy Sullivan, the foreman, and William Scheutte, the electrician, were Italians. All possible precautions have been taken in conducting the work against an accident of this nature. At the point where the cave-in occurred the tunnel is about 110 feet below the surface. Only about 500 feet remain to be bored in order to make connection with the section of the tunnel which is being bored in a northerly direction. The night gang had entered the tunnel for the purpose of putting in the "wall plate," following the loosening of the rock by the blast, when, without warning, the ceiling of rock gave way. The man in charge was considered a very good and cautious workman, and it was his custom to sound the walls and roof after a blast to see if they were solid.

PERSONAL MENTION.

DR. ARTHUR W. SMITH has been appointed professor of physics at the University of Michigan.

PROFESSOR R. B. OWENS has been elected president of the electrical section of the Canadian Society of Civil Engineers.

MR. M. L. H. WILLIER, professor of physics at the Lyceum, at Nantes, France, has been appointed director of the Meteorological Observatory in that city.

MR. G. H. MARX, assistant professor of mechanical engineering at Stanford University, has received a year's leave of absence, which he will spend in Germany.

MR. FRANCIS GRANGER, 26 Cortlandt street, New York city, has been appointed the sole New York representative for the L. B. Allen Company, Incorporated, of Chicago, Ill.

MR. H. B. HEWITT, the Missouri representative of the Stromberg-Carlson Telephone Manufacturing Company, formerly located at Keithsburg, Ill., is now permanently located at Chillicothe, Mo.

MR. GEORGE W. COLLES, chief engineer of Marion & Marion, Montreal, Canada, has resigned this position and opened an office as consulting mechanical and electrical engineer in Milwaukee, Wis.

MR. BURCHAM HARDING, for several years with the Westinghouse Electric and Manufacturing Company, has resigned to become manager of the local office of a leading real estate company of Pittsburg, Pa.

MR. R. J. RUSSELL has severed his connection with the Wagner Electric Manufacturing Company, and has accepted a position as business and sales manager of the H. E. Lindsey Electrical Supply Company, of St. Louis, Mo.

DR. HENRY S. PRITCHETT, president of the Massachusetts Institute of Technology, sailed on October 5 from New York on the steamer Kronprinz for Germany. It is expected he will be absent from Boston about four weeks.

MR. J. P. CLARK, formerly manager of the Terre Haute electric system for Stone & Webster, Boston, and later representing their interests at Dallas, Tex., is to become manager of the Indiana Union Traction Company's lines at Fort Wayne, Ind.

MR. RAY TITUS WELLS, Ph. D., has been appointed assistant professor in charge of electrical engineering in the newly organized school of applied science of the State University of Iowa, at Iowa City. A new electrical laboratory is now being equipped under his direction.

MR. JAMES WILLIAMS has been appointed chief engineer of the Columbus, Delaware & Marion Electric Railroad Company, with headquarters at Prospect, Ohio. Mr. Williams succeeds Mr. Lee Fisher, who has been appointed to a similar position with the Joliet, Plainfield & Aurora Railway, of which his father, Mr. H. A. Fisher, is president.

MR. E. A. FISHER, city engineer, Rochester, N. Y., in an address on the morning of October 22, before the annual convention of the American Society of Municipal Improvements, in session at Indianapolis, Ind., stated that Rochester was one of the best lighted municipalities in the country and that Main street was better lighted than any other thoroughfare in the world. Mr. Fisher also made a report to the convention on "Improvements Made in Street Lighting," which covers the improvements made to lighting systems throughout the country.

MR. F. B. DUNCAN has been appointed manager of the Akron (Ohio) Electric Manufacturing Company. About two years ago Mr. Duncan resigned his position as general superintendent, which he had held for about five years with the Northern Electrical Manufacturing Company, of Madison, Wis., to accept a similar position

with the Akron company, and his present promotion is an evidence of the company's appreciation of his services. During his connection with the Akron company, Mr. Duncan has redesigned its entire line of machines, and the growth of its business has been very marked.

MR. W. O. WOOD, formerly general superintendent of the Detroit, Mich., rapid transit system, has been appointed superintendent of the elevated division of the Brooklyn Rapid Transit Company, of Brooklyn, N. Y., succeeding Mr. George W. Edwards, resigned. Mr. Wood has had extensive experience in the operation of steam and electric railways, and the first move in his new position will be to perfect and apply to the elevated lines the merit system of discipline recently adopted by the company, and in working out for the elevated lines the system of train despatching recognized as standard by the leading steam roads.

MR. HORACE H. ESSELSTYN, engineer for Westinghouse, Church, Kerr & Company, who had charge of building the Grand Rapids, Grand Haven & Muskegon Company's line into Grand Haven, Mich., has gone to St. Louis to superintend the installation of the power plant in Machinery Hall of the Louisiana Purchase Exposition. The contract for this plant includes four 2,000-kilowatt units, besides various auxiliary engines, turbine pumps, etc., all of Westinghouse make. While in Michigan, in addition to building the interurban line to Grand Haven, Mr. Esselstyn built the new drawbridge across the Grand river at Grand Haven to accommodate both the interurban cars and the highway traffic, the contract for all of this work having been awarded to Westinghouse, Church, Kerr & Company.

NEW INCORPORATIONS.

HARRISBURG, PA.—Lancaster & Southern Street Railway Company. $84,000. Incorporators: James G. McSparran, of Furniss; C. H. Fondersmith, William Wohlsen, Frederick Shofl and T. K. Worthington, Lancaster.

ST. PAUL, MINN.—Farmers' Telephone Company. $12,500. Incorporators: C. B. L. Bohan, S. Greendahl, M. P. Mortenson, J. Elkof, J. A. Grundahl, A. Westlund, A. Salberg, O. L. Titrud, V. N. Millquist, G. A. Hohner, Stockholm; A. Hord and C. J. Carlson, Cokato.

MOLINE, ILL.—Dixon, Rock Falls & Southwestern Electric Railway Company. $50,000. Directors: O. E. Maxson, A. S. Goodell, A. J. McNeill, R. L. Leitsch and H. L. Sheldon, of Rock Falls. To build an electric railroad from Dixon, in Lee County, to Rock Island.

CHARLESTON, W. VA.—Paden City, Middlebourne & Salem Railway Company. $100,000. Incorporators: Thomas A. Watkins and George R. Wallace, of Pittsburg; Robert Miller, of Paden City; George E. Work, of Sisterville, W. Va., and E. L. Robinson, of New Martinsville, W. Va. To build and operate an interurban railway system through the cities named.

PITTSBURG, PA.—Irwin & McKeesport Railway Company; $45,000; directors, Charles Fritchman, Frank M. Fritchman, William W. George, John George, Irwin; Joseph C. Boyd, Pittsburg. The Lancaster & Southern Street Railway Company; $84,000; directors, C. A. Fondersmith, William Wohlsen, Thomas K. Worthington, Frederick Shoff, Lancaster; James G. McSparran, Furniss. California & Allen Port Street Railway Company; $50,000; directors, W. C. Smith, Edward C. Drum, C. H. Drum and A. T. Morgan, California. Bank & Broad Street Railway Company; $5,000. The Farmersville & Terre Hill Street Railway Company; $48,000; directors, E. H. Burkholder, A. E. Burkholder, S. M. Seldomridge, Farmersville; Dr. B. J. Reemsnyder, Hinkletown; John H. Fry, Lancaster. The Wilkesbarre Terminal Railroad Company; $35,000; directors, William H. Smith, Arthur P. Goedecke, F. Walk, Jeddo.

LEGAL NOTE.

THE BRADLEY-HALL ALUMINUM PATENTS LITIGATION —The United States Circuit Court of Appeals for the Second District has rendered a decision sustaining the Bradley patent No. 168,148, for electric smelting, instructing that a decree be entered in favor of the Electric Smelting and Aluminum Company for an injunction against the Pittsburg Reduction Company, and an accounting for profits, damages and savings on its manufacture of aluminum to date.

ELECTRICAL SECURITIES.

If there was one thing for which last week's market could be called remarkable it was for its resistance to the effects of bad news. The adverse decision in the Amalgamated Copper suit, with the consequent closing of large works and the throwing out of employment of some 20,000 men, was unfortunate; and, coupled to this, the failure of two Baltimore trust companies and the suspension of several Pittsburg institutions brought about a condition which would, no doubt, have proved disastrous earlier in the financial depression which has been witnessed for over a year. It is this market resiliency which lends constant hope to the optimistic side of the market. While it is conceded on every hand that there is in progress an industrial reaction, still the absolute lack of confidence and the abandonment of prices which the decline has brought forth strengthen the opinion in many quarters that these declines have more than offset the possible shrinkage in absolute value of stocks. As soon as a period of readjustment sets in there will, no doubt, be rallies in other industrials, a condition which has marked several naturally high-class securities within the last two weeks. This readjustment will, in all probability, show that, along with the general decline, there has been more than one stock pounded down to a great deal less than its normal value.

ELECTRICAL SECURITIES FOR THE WEEK ENDING OCTOBER 24.

New York:	*Closing.*
Brooklyn Rapid Transit	33½
Consolidated Gas	175
General Electric	148
Kings County Electric	150
Manhattan Elevated	133¼
Metropolitan Street Railway	107
New York & New Jersey Telephone	140
Westinghouse Manufacturing Company	160
Boston:	*Closing.*
American Telephone and Telegraph	123½
Edison Electric Illuminating	235
Massachusetts Electric	77½
New England Telephone	123
Western Telephone and Telegraph preferred	75

It is stated that the earnings of the New England Telephone Company for the past six months show an increase even larger than the average yearly growth for several years past. The gross business of the company in 1902 increased 14 per cent, while in 1901 the increase was 13 per cent.

Philadelphia:	*Closing.*
Electric Company of America	7⅜
Electric Storage Battery common	44
Electric Storage Battery preferred	48
Philadelphia Electric	5⅞
Union Traction	43½
United Gas Improvement	79
Chicago:	*Closing.*
Chicago Telephone	115
Chicago Edison Light	137
Metropolitan Elevated preferred	53
National Carbon common	15
National Carbon preferred	85
Union Traction common	4½
Union Traction preferred	25

The directors of the Chicago Edison Company have declared the regularly quarterly dividend of 2 per cent, payable November 2. Books close October 24 and reopen November 3.

The annual report of the Metropolitan Elevated Company for the year ended June 30, 1903, is as follows: Gross earnings, $2,094,008; expenses, $1,037,181; leaving net earnings of $1,056,827; other income, $10,462, giving a total income of $1,067,289. The amount paid for charges and dividends was $1,162,886, leaving a deficit for the year of $95,597, as compared with a deficit of $46,639 for 1902.

The National Carbon Company has declared the preferred regular quarterly dividend of 1¾ per cent, payable November 14. Books close November 4 and reopen November 16.

The present earnings of the Chicago Union Traction Company are said to be at the rate of $1,000,000 a year in excess of the last fiscal period.

ELECTRIC LIGHTING.

RUSH CITY, MINN.—Grantsburg will install an electric light plant.

THOMPSONVILLE, CT.—The Enfield Electric Light and Power Company has a force of men at work making extensions to its system.

TOULON, ILL.—The new electric light system of Galva is expected to be in operation in about two months. The poles are now being set and the wiring will soon commence.

MURRAY, IOWA—The Osceola Electric Light Company, of Osceola, Iowa, purposes to furnish electric current to this city by means of an electrical transmission line from Osceola.

BOSTON, MASS.—A contract has been awarded for the building of an addition to the Gloucester Electric Lighting Company's plant. The building will be of brick and will cost $8,000.

SAN FRANCISCO, CAL.—A first mortgage has been filed for record covering a loan of $400,000 by the California Safe Deposit and Trust Company to the Mutual Electric Light Company, secured by a bond issue in the sum named. The lighting company mortgages all of its properties now owned or hereafter to be acquired by the corporation.

KANSAS CITY, MO.—The Leavenworth Light and Heating Company has been awarded a contract to furnish arc lights at Fort Leavenworth. The lamps are to run all night, and the company is to receive $80 a lamp a year. The company also agrees to furnish small electric lights to burn all night for 5.35 cents. The contract for lighting the fort is to run for ten years.

ALBION, N. Y.—The board of aldermen has made a new contract with the Albion Electric Light and Power Company for street light service. The price to be paid is $65 per lamp. The lights are to be turned on half an hour after sundown and burn until one o'clock the next morning on all nights except when the moon is actually shining. On one month's notice the board may, if it wishes, change to an all-night service on the basis of $85 per lamp.

FORT MADISON, IOWA—At a recent meeting of the council, a resolution was adopted, offering the Fort Madison Electric Light and Power Company a contract for the public lighting of the streets on a monthly basis, at the rate of $60 per lamp per year. The proposition is refused by the company on the ground that to do the necessary work would entail an expense which would not be justified without a contract of at least one year's duration.

SALT LAKE CITY, UTAH—A deal has been concluded whereby the Utah Light and Power Company will acquire 2,000 horse-power which will be generated at the Garland sugar factory and transmitted to Ogden and Salt Lake over transmission lines to be constructed from the factory to the company's transmission line at Ogden. The sugar company will have a power plant in connection with the factory, but will require the power only about three months of the year, and during the remaining nine months the Utah company will have the use of the power generated.

ST. PAUL, NEB.—At a meeting of the city council a franchise was granted the Loup Valley Electric Company for the installation of an electric lighting system in St. Paul. The term of the franchise is twenty-five years. A maximum limit of seventeen cents per 1,000 watts, meter rate, or seventy-five cents a month for sixteen-candle-power lamps, $1.50 for thirty-two-candle-power and $8 for 1,200-candle-power, flat rate, is fixed. The company is given ninety days from the date of the franchise to commence work on the plant and six months thereafter for its completion.

GRAND RAPIDS, MICH.—General Superintendent Meyer, of the municipal lighting station, in his annual report for last year, informs the board of public works that the circuits are now carrying their maximum load and that no new lamps can be added without increasing the capacity. He recommends that two new complete circuits be constructed, one on the east and the other on the west side. The cost of operation of the lighting plant and system has increased this last year to $43.40 per lamp, as compared with $40.99 during the year previous. It is claimed that the increase in the cost of coal is responsible for this condition. The total income of the lighting department was $36,040.15, and the expenses were $31,290.26.

TELEPHONE AND TELEGRAPH.

OSHKOSH, WIS.—The Wisconsin Telephone Company will erect an exchange at Manitowoc.

DES MOINES, IOWA—At Cedar Falls the Iowa Telephone Company will rebuild its exchange throughout.

CONCORD, N. H.—The Citizens' Telephone Company, of Laconia, has increased its capital stock to $70,000.

DES MOINES, IOWA—The Jasper County Telephone Company has increased its capital stock from $100,000 to $150,000.

LOS ANGELES, CAL.—The new Home Telephone Company will erect a new building in San Bernardino, to cost $16,000.

CHATTANOOGA, TENN.—The Bristol & Washington County Telephone Company has secured an entrance into Greenville.

MINNEAPOLIS, MINN.—The Northwestern Telephone Company will build a $12,000 addition for toll lines to its east side exchange.

WASHINGTON, D. C.—The Frost Telephone Company has been incorporated by E. F. Frost, C. W. Van der Hoogt and D. G. Clark.

DUBUQUE, IOWA—It is stated that the Iowa Telephone Company will within the next year expend $150,000 in improvements in this city.

CAIRO, ILL.—A franchise was granted recently to the Central Union Telephone Company to erect and operate a telephone exchange in Thebes.

GUTHRIE, OKLAHOMA—The Lamont & Eddy Rural Telephone Company, of Lamont, has been incorporated by John Cowen, Art Hollopeter and Swan Olson.

CINCINNATI, OHIO—The Cincinnati Telephone Company has let the contract for the erection of a new exchange at Court and Race streets to Griffith & Sons.

MONTGOMERY, ALA.—The Southern Bell Telephone Company has established a long-distance line connecting Huntsville with New Market and Deposit, Ala.

SPRINGFIELD, ILL.—The Alexis Telephone Company, Alexis, has been incorporated with a capital of $2,000. The incorporators are Charles Rogers, J. W. Standley and W. A. McKnight.

MADISON, WIS.—The Port Wing Telephone Company, Port Wing, Bayfield County, has been incorporated with a capital stock of $5,000. The incorporators are Axel Johnson, Carl Hogfeldt and Swanson Odgen.

MOUNT MORRIS, N. Y.—The Rural Telephone Company, of Dalton, has been granted a franchise by the Nunda village trustees for the use of the streets for the erection of poles and the stringing of wires.

DOWNS, KAN.—The Downs Western Telephone Company has been incorporated with a capital stock of $50,000. C. W. Baldwin is president; M. F. Hudson, vice-president; R. Broderick, secretary, and J. R. Loomis, treasurer.

RICHMOND, VA.—The Albemarle Mutual Telephone Company has been granted permission to change its corporate name to the Farmers' Mutual Telephone Company. T. F. Powell is president and Charles Miller, secretary.

READING, PA.—At a recent meeting of the Conestoga Valley Telephone Company, held at Morgantown, plans were made for an extension of the company's line to Birdsboro, and also for connections with Reading and other points.

JAMAICA, N. Y.—The New York & Long Island Telephone Company has bought the franchise and privileges of the Knickerbocker Telephone Company in New York, Brooklyn and Queens Borough, and has consolidated with the South Shore company.

TROY, N. Y.—The Champlain Telephone Company has been incorporated to connect the village of Champlain with Perry's Mill, Coopersville and Chazy. The capital stock is $2,000 and W. O. Clark, James Burroughs, T. Dickinson, William Fraser, Hiram Briggs, W. H. Dunn and others are the directors.

NASHVILLE, TENN.—The Lauderdale Telephone Company, of Lauderdale County, has been granted a charter with a capital stock of $1,500. The purpose is to manufacture electricity for telephone and general purposes and to construct, equip and operate a line from Ripley to Durhamville. Orpa W. Rice, J. Holmes and others are the incorporators.

ELECTRIC RAILWAYS.

READING, PA.—Operations have been begun on the construction of the Pottstown & Reading trolley line, the completion of which will afford trolley communication all the way to Philadelphia. It is proposed to have the road finished before March 1.

OXFORD, PA.—The town council has granted the right to lay tracks to the Wilmington, Kennett & West Chester trolley road. The tracks are laid from Wilmington to within about twelve miles of the town, and the projectors promise to have the road in operation by the new year.

HEMPSTEAD, L. I.—The New York & Long Island Traction Company has accepted the franchise granted by the town highway commissioners to build a trolley line from Freeport east to the town line at Seaford, on town roads and a private right of way. The line to be built will be the first link in the proposed route to Babylon.

ASHTABULA, OHIO—It is reported that the Conneaut & Erie Traction Company will extend its line from Girard, Pa., south to Conneaut Lake. It was formerly intended to run the line to Albion, but it is now stated on good authority that the line will run from Girard to Lockport, thence to Cranesville, Albion, Conneautville and Conneaut Lake.

MUNCIE, IND.—The Muncie City council has given the Indiana Union Traction Company a fifty-year franchise which permits the laying of double tracks as suggested by the company. Rights were given which will permit a loop surrounding the site recently bought for a terminal station. A station to cost $100,000 will be erected by the traction company.

SPRINGFIELD, ILL.—Articles of incorporation have been filed by the Charleston, Champaign & Northern Interurban Railway Company. The principal offices will be at Charleston and the capital is $10,000. The road is to be constructed from Charleston, Coles County, to Homer, Champaign County. The incorporators and first board of directors are W. R. Patten, W. F. Jenkins, J. B. Mitchell, C. L. Lee and J. L. Shisland, all of Charleston.

STAUNTON, VA.—There has been filed in the Corporation Court a charter for the Virginia Power Corporation, with a capital of from $500 to $50,000, the home office of same to be in Staunton. Mr. C. Russell Caldwell is president and Mr. Lawrence H. Peyton, Herbert J. Taylor, of Staunton; J. J. Nicholas, of Port Republic; John Fulton, of Mt. Meridian, constitute the board of directors. The company is empowered to use power for manufacturing, mining and the like.

MONONGAHELA, PA.—Donora capitalists have organized a new street car company, to be called the Monongahela & Clairton Street Railway Company. At Clairton the route will connect with the Frick line and make a complete service from Pittsburg to Donora. At Monongahela the line will make connections to Monessen, Bellevernon and Fayette City. The directors and officers are: President, J. M. Mullen; secretary, Oliver S. Scott; treasurer, Herbert Ailes.

PHILADELPHIA, PA.—The General Traction Company, which has filed articles of incorporation in the county clerk's office, Camden, N. J., with a capital stock of $100,000, is formed for the purpose of building and operating trolley lines between Camden and seashore resorts. One of the lines, it is said, will run to Atlantic City and another to Cape May, tapping other resorts along the South Jersey coast. The president of the General Traction Company is W. W. Benson, of Philadelphia.

JERSEY CITY, N. J.—The North Jersey Street Railway Company recently absorbed by the Public Service Corporation of New Jersey, has bought a tract of land on the Hackensack river at Jersey City for which it paid $12,500. The river frontage is 300 feet, the plot being 1,140 feet deep at the north end and 935 feet at the south end. It will be used for a new power-house in connection with an extension of lines on the west side of Jersey City Heights contemplated by the Public Service Corporation.

PHILADELPHIA, PA.—The Burlington County Traction Company has entered into a contract with the Interstate Construction Company to complete the electric road from Moorestown to Mount Holly, N. J., which has been under construction for a year past, and upon which work was temporarily suspended. The completion of the road will give Camden direct trolley lines to Mount Holly and Burlington. The line will be ten miles long and equipped for high-speed service, and it is hoped to have it completed in six months.

HARRISBURG, PA.—The Philadelphia Rapid Transit Company has obtained a charter at Harrisburg to build the first link in the short line which the company intends to construct from the centre of Philadelphia to Willow Grove. The company is called the Glenside & Willow Grove Street Railway Company. The capital is $25,000, and the charter permits of a line from Keswick avenue, Philadelphia, to Willow Grove Park. The president is C. P. Weaver, special agent of the Philadelphia Rapid Transit Company.

ALLENTOWN, PA.—Representatives have been seeking the right of way of landowners between Macungie and East Texas for a trolley line to connect with the Allentown-Reading line with Macungie. The Reading Traction Company is endeavoring to extend its line along the East Penn Railroad, where its road is not yet built. The traffic is to include freight business, and the run from Allentown to Macungie is to be made in thirty-eight minutes. As soon as the rights are granted work is to begin on the branch.

WASHINGTON, IOWA—The articles of incorporation for the new interurban line to be known as the Iowa City, Kelloma & Washington Railway were filed here recently, with an authorized capital stock of $50,000 and the right to increase the amount of stock at any time, and the work of surveying and buying the right of way will begin at once. This is the first interurban in this part of the state. The officers of the corporation are George Rodman, president; W. P. Coast, vice-president; W. J. Welsh, secretary; C. M. Keck, treasurer. The board of directors includes the officers and the following: L. G. Smith, G. S. Carson, Amos Alberson and S. W. Brookhart.

WATERVILLE, ME.—A. F. Gerald, of Fairfield, has purchased the water power at Fowler's rip on the Sebasticook river, one and one-half miles above Benton Falls, and will improve it at once. He buys the charter of the Sebasticook Manufacturing and Power Company, which has been running some six years. Mr. Gerald expects to have a dam completed by January 1, getting a head of twenty-three feet and some 1,000 horse-power. He will establish electric generators, and, running a line of wire to the Kennebec river, expects to sell power to people in Waterville and Fairfield. It is five and one-half miles to Waterville and two and one-half miles to Fairfield. The whole plant which Mr. Gerald proposes to have will cost some $50,000.

PROVIDENCE, R. I.—The Providence & Burrillville Street Railway Company, which is planning to build a double-track electric railway for passenger and freight service between Woonsocket and this city, connecting with the Rhode Island Company's system to the south, and Woonsocket Street Railway Company to the north, has organized and elected as directors Edgar K. Ray, of Franklin, Mass.; Edward H. Rathbun and Frank E. Holden, of Woonsocket; F. E. Bartlett and Francis Fagan, of Burrillville; E. B. A. D. Thayer, of Franklin, and Thomas Martin, of Chelsea. The following named officers have been elected: President, E. H. Rathbun; general manager and treasurer, E. K. Ray; secretary, Frank E. Holden. The company has an authorized capital of $200,000, and will apply for franchises in Lincoln and North Smithfield. Construction work is to begin in the spring, surveys and estimates of cost, etc., having already been made.

WATERBURY, CT.—Rapid progress is being made on the project of the New Milford Power Company to supply various divisions of the Connecticut Railway and Lighting Company with power generated along the Housatonic river in the towns of New Milford and Kent and transmitted over long distances. The large plants of the power company at Boardman's bridge and Bull's bridge on the Housatonic are nearly completed. The work of constructing the distributing power plants at Waterbury, New Britain and Cheshire is being pushed. The needed rights of way for the poles and wires along the entire distance have all been secured, with a few exceptions. The few property-owners who have not yet deeded the desired rights of way will do so shortly. The New Milford company will supply power for both trolley and lighting purposes for the Waterbury, New Britain, Southington and Cheshire divisions of the street railway combine. The electric power line from New Milford to Waterbury will be in duplicate, with two sets of poles and wires, and for the remainder of the distance there will be a single set of poles, carrying six wires.

INDUSTRIAL ITEMS.

THE EMPIRE ELECTRIC SUPPLY COMPANY, 57 West Jackson Boulevard, Chicago, Ill., has added a full line of electric lighting and telephone supplies and is now prepared to quote prices and make prompt shipments.

THE ELECTRIC GAS LIGHTING COMPANY, Boston, Mass., is sending out bulletin No. 1, entitled "The Specializing of Interior Telephone Apparatus." This describes the details of the Samson telephone apparatus which this company is placing on the market.

STANLEY & PATTERSON, 93 Liberty street, New York city, manufacturers of general electrical supplies, operate a department devoted exclusively to electrical engineering and electrical construction and repair work. This department is operated in connection with their manufacturing and supply department.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., is mailing a description and price list of Dixon graphite lubricants. This booklet illustrates the form in which the special graphite compositions are put up, and details the special work for which each is designed. The booklet will be sent upon request.

THE DAYTON MANUFACTURING COMPANY, Dayton, Ohio, is distributing its catalogue No. 110. This is a handsome production, printed on heavy cut paper, and shows the applications of the "Silvey" electric light for railway cars and appliances pertaining thereto, "Silvey" storage batteries, dynamos, motors, etc., and every description of car furnishings.

THE PAIRPOINT CORPORATION, New Bedford, Mass., is the headquarters for the celebrated "McCreary" shades. These are made in Empire or green finish, silver finish, and Colonial or white finish. These shades are made in seven, eight, nine and twelve-inch sizes, and they are also made for sixteen and thirty-two-candle-power lamps.

THE CLEVELAND CAR AND CRANE COMPANY, Wickliffe, Ohio, is distributing a series of booklets describing Cleveland cranes of the electric traveling type, hand and electric jib post and car types, hand power traveling cranes, and Armington electric hoists built by the Cleveland company. This covers a line of hoisting apparatus of a wide range, and the bulletins are worth writing for.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., will be pleased to send to any one interested, upon request, bulletin No. 38. This describes a line of form L motors, which are adapted for either wall or ceiling suspension. The line includes machines of from one-quarter to three horse-power, and the design of these motors is such that they can be used with equal effectiveness for direct, belt or gear driving.

THE F. BISSELL COMPANY, Toledo, Ohio, is distributing throughout the electrical field a mailing card having attached to it a spider wire cleat for cable pole work and construction. This is of tough maple, held by screws or nails, and drilled for five wires for the full end of the cross-arm. When used with bridle rings this makes a holder for spider wires between the pole-houses and the insulators. The sample sent is for a small wire.

PASS & SEYMOUR, Solvay, N. Y., are meeting with a brisk demand for their decorative and wiring specialties. The city of Allentown, Pa., was elaborately decorated during the week of the State Firemen's convention, held there recently. The illuminations were equal to those seen in larger cities, and the work reflects great credit on the electrician, Mr. H. H. C. Smith, of Allentown. Pass & Seymour's goods were greatly in evidence on this occasion.

THE STANDARD PAINT COMPANY, 100 William street, New York city, is distributing an attractive mailing card advertising its "Ruberoid" roofing. This is a durable roofing, to take the place of tin, iron and shingles. It is built upon modern scientific principles, containing a water-proof, acid-proof and fire-resisting saturation, and does not dry out from long exposure nor melt away from heat, remaining elastic and pliable. This roofing has been on the market for twelve years and has given constant satisfaction.

THE H. T. PAISTE COMPANY, Philadelphia, Pa., reports gratifying sales for its three-screw fixture socket. This fixture socket, the manufacturer states, possesses many advantages in its holding together under all sorts of strains in places such as trolley and railway cars, where an extra fastening is necessary. The company has just completed a shipment of its large order for the United States Government printing office, Washington, D. C. This contract particularly specified that the sockets must be able to stand the vibration of the building, due to the running of the large printing-presses.

JAMES T. PEARSON, Burnley, Lancashire, England, electrical and mechanical engineer and manufacturer, will be pleased to send to any one interested illustrated literature detailing his safety apparatus and automatic blocking and braking devices for tramway systems. Other recent additions to the literature produced by Mr. Pearson are short treatises on "The Destruction of Gas and Water Pipes by the Leakage of Current from Tramways, and Remedies Therefor," and a description of the system which he has invented for operating tramways without a third rail or without a trolley equipment.

THE KINSMAN ELECTRIC AND RAILWAY SUPPLY COMPANY, 91 Liberty street, New York city, is meeting with great success in marketing its improved "Daylight" desk lamp. This electric desk lamp is constructed upon scientific principles and is of great value to those who are compelled to do desk work. The light is soft and abundant, and so distributed as to leave no dark shadows or corners on the desk. At the same time, the lamp itself is entirely shaded from the eyes. This lamp has an ornamental appearance and is adjustable in six directions. It in no way interferes with the opening and closing of a roll-top desk, and requires no electric wires in the desk.

THE AMERICAN SCHOOL OF CORRESPONDENCE at the Armour Institute of Technology, Chicago, Ill., announces the following incident, as exemplifying the value of correspondence instruction: "Mr. George B. Tinkham, for a number of years engineer of the Upson Nut Company, Cleveland, Ohio, through native skill and knowledge gained by correspondence study, invented and patented a hydrocarbon device for increasing the efficiency of a brick furnace. On the suggestion of the American School of Correspondence, Mr. Carl S. Dow, chief of the department of mechanical engineering, was selected as best fitted to give an impartial judgment on the value of the apparatus, both from the viewpoint of the manufacturer and the inventor. The apparatus is practical and is, no doubt, of much value, and credit is due to Mr. Tinkham as an inventor. According to his own statement, Mr. Tinkham owes nearly all his knowledge of the theory of engineering to his courses with the American School of Correspondence."

THE FORT WAYNE ELECTRIC WORKS, Fort Wayne, Ind., manufacturer of the "Wood" systems, in bulletin No. 1048 describes and illustrates belted direct-current generators, types MP, LB and MPL. The small generators are built in sizes from three-quarters to thirty kilowatts, and are two-bearing machines. The medium size line consists of six-pole generators having separate field frame, laminated pole-pieces and two bearings. These vary in capacity from twenty to ninety kilowatts. The larger generators are three-bearing machines and range from 100 to 400 kilowatts. This bulletin gives a list of plants in the United States where from one to four machines of this type are in operation. Other literature which the Fort Wayne company is now distributing is a blotter bearing an illustration of a side wall with a bracket hanger carrying a Fort Wayne type A transformer. Catalogue No. 2007 details the parts of direct-current series form C "Wood" arc lamps, and there is also a reprint of an article by Mr. Edward A. Wagner, on transformer insulation. An interesting letter from Mr. R. Dean, the superintendent of the East Chicago lighting station, relates the successful operation of a thirty-kilowatt, 6,600-volt type A transformer during a severe lightning discharge on the evening of July 9. In this case the lightning discharge leaped from the connection clips to the iron strap supporting the porcelain block, a distance of about three inches, blackening the inside of the case and burning the connections away. The connection block was replaced and the transformer connected into circuit and tested for weak insulation. The transformer windings were found to be absolutely uninjured.